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AFOSR-TR-97

0185

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1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE	3. REPORT TYPE AND DATES COVERED FINAL 01 May 96 To 30 Apr 97	
4. TITLE AND SUBTITLE RETINAL NEUROBIOLOGY AND VISUAL PROCESSING			5. FUNDING NUMBERS F49620-96-1-0128 2313/AS 61102F	
6. AUTHOR(S) Dr David Copenhagen				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Federation of American Societies for Experimental Biology 9650 Rockville Pike Bethesda MD 20814-3998			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFOSR/NL 110 Duncan Ave Room B115 Bolling AFB DC 20332-8080 Capt William P. Roach			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release: distribution unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) The sessions were organized as follows: 1) Visual Performance, 2) Signal Transduction and Modulation in ON Bipolar cells, 3) Mechanisms and Functions of Gap Junction Coupling, 4) Ionic Channels to Machines, 5) Synaptic Mechanisms in the Outer Plexiform Layer, 6) "Potpourri" (Speakers selected from those who submitted poster abstracts), 7) GABA _c Receptors, 8) Synaptic Processes in the Inner Plexiform Layer and 9) Ecology of Vision. The response to this conference was very enthusiastic. Thirteen of 59 participants who completed evaluation forms ranked the meetings as the best conference they had attended. 41 of 59 ranked it as being in the top 10%. The attendance has grown steadily since the first conference on retina was held in 1992.				
14. SUBJECT TERMS			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT (U)	18. SECURITY CLASSIFICATION OF THIS PAGE (U)	19. SECURITY CLASSIFICATION OF ABSTRACT (U)	20. LIMITATION OF ABSTRACT (U)	

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FINAL REPORT

United States Air Force

CONFERENCE GRANT: FASEB Summer Research Conference on
Retinal Neurobiology and Visual Processing

GRANT NUMBER: F49620-96-1-0128

PERFORMANCE PERIOD: 5/01/96 through 4/30/97

GRANT AMOUNT: \$7,500

PRINCIPAL INVESTIGATOR: David Copenhagen

GRANTEE INSTITUTION: Federation of American Societies for Experimental Biology
9650 Rockville Pike
Bethesda, MD 20814-3998

DATE OF REPORT: October 3, 1996

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FASEB Summer Conference
July 13-18, 1996
Saxtons River

RETINAL NEUROBIOLOGY AND VISUAL PROCESSING

This meeting was the third Summer Conference focused on the retina. There were 30 invited speakers who were divided about evenly into 9 sessions. The participants were a good mix of younger and more established scientists from within US. and abroad. Age-wise most of the participants fell evenly into groups of 30, 40 and 50 year-olds. Discipline-wise, we drew participants from areas in molecular biology through computational neuroscience.

The sessions were organized as follows: 1) Visual Performance, 2) Signal Transduction and Modulation in ON Bipolar cells, 3) Mechanisms and Functions of Gap Junction Coupling, 4) Ionic Channels to Machines, 5) Synaptic Mechanisms in the Outer Plexiform Layer, 6) "Potpourri" (Speakers selected from those who submitted poster abstracts), 7) GABA_C Receptors, 8) Synaptic Processes in the Inner Plexiform Layer and 9) Ecology of Vision. The first session highlighted how the retina sculpts and limits visual performance. A particularly striking talk by Tom Reuter tied the visual performance of prey catching in toads to the "noise" generated in rods of this animal. The session on ON Bipolar cells included a talk by Duvoisin who was attempting to clone the elusive cGMP-gated channel in these neurons and a paper by Laura Frishman who was able for the first time to dissect the signal generated by ON bipolar when recording from anesthetized cats. This technique promises to be useful to diagnose visual function in human subjects. In the gap junction coupling sessions the talks were highlighted by work of Massey and Mills who are beginning to dissect the differences in various retinal gap junction complexes by observing the differential flow of different-sized dye molecules between coupled cells. The session on ionic channels flowed seamlessly from discussion of specific ion channels in different fly eyes to a video-taped presentation of a robot whose visual behavior was based on the circuitry of the fly's visual system. In the synaptic mechanisms session, the topics ranged from the regulatory processes that might control the release of glutamate from rods and cones to how the glutamate actually diffuses to the postsynaptic cells to the neuromodulatory actions of glutamate. It is clear that the speakers are working in an intensely-studied and very productive area that promises to be an exemplary system to understand glutamatergic synaptic transmission.

In order to provide opportunities for "hot, new" topics, we devoted one session to platform presentations from poster submissions. All of the talks were well received. The topics ranged from an examination of the calcium currents in mouse bipolar cells to the waves of calcium that course through neonatal retinas during development to a new behavioral test for zebrafish vision. A new receptor for the inhibitory neurotransmitter GABA was discovered recently. This receptor is known to control synaptic transmission from bipolar cells to ganglion cells. Our session on these GABA_C receptors showed that much progress has been made in understanding the functioning of these receptors at the molecular level. For the session on synaptic processing in the inner plexiform layer the speakers presented striking new findings on how

Schedule of Scientific Sessions and Workshops

(As of June 27, 1996)

(Subject to minor modifications)

14 July

Visual Performance

Moderator: Peter Sterling

8:40-9:00 am Welcome etc.

9:00 Introduction

9:10 am Marty Banks (Title?)

9:55 am Stelios Smirnakis "Retinal processing adapts dynamically to second order image statistics."

10:40 am Coffee Break

11:00 am Tom Reuter "When does the random distribution of discrete photoreceptor events limit the sensitivity of the visual system?"

11:45 am *David Brainard "Behavioral consequences of retinal sampling: interactions between space and color"

2:00-4:00 PM **Workshop: Computational Approaches to Retinal Research**

Moderator: Udi Kaplan

- 1) Norberto Grzywacz "A model of directional selectivity: the melee among GABA, acetylcholine, and glutamate."
- 2) Buster Boahen "The role of spatio-temporal highpass filtering in the inner vertebrate retina: A computational approach."
- 3) William Beaudot "Adaptive and spatiotemporal dynamics in the vertebrate retina: A 'structure to function' approach."
- 4) Frank Werblin "Computational prediction and experimental verification of a new form of edge-enhancement (without lateral inhibition) in retina."

Signal Transduction and Modulation in On Bipolar Cells

Moderator: David Copenhagen

7:30 pm Introduction

7:40 pm Robert Duvoisin "Identification and characterization of a novel cGMP-gated channel from mouse retina."

8:15 pm Scott Nawy "Kinases and regulation of the mGluR6 cascade."

9:00 pm Laura Frishman "Response kinetics of rod bipolar cells at scotopic levels in thecat. "

15 July

Mechanisms and Functions of Gap Junctional Coupling

Moderator: Steven DeVries

9:00 am Introduction

9:10 am Doug McMahon "Structure, function and modulation of retinal gap junction channels."

9:55 am Steven Mills "Quantitative dye coupling in the retina."

10:40 am Coffee Break

11:00 am Julie Schnapf "Rod/Cone Coupling in the Macaque Retina."

11:45 am Robert Smith "Function of electrical coupling in retinal networks: adaptive filtering and noise reduction."

2:00- 4:00 PM **Workshop: Optical Recording from the Retina**

Moderator: Markus Meister

1) Marla Feller "Using fluorescence imaging to measure patterns of activity in the retinal ganglion cell layer."

2) Ralph Nelson "Use of voltage sensitive dyes in studies of receptor pharmacology in dissociated retinal neurons."

3) Zhuo-Hua Pan "Confocal microscopic imaging of calcium dynamics and regulation in retinal neurons."

4) David Wellis "Imaging activity along neural processes in retinal slices."

Insect Vision: Ionic Channels to Machines

Moderator: Joel Davis

7:30 pm Introduction

7:40 pm Simon Laughlin "Retinal response dynamics and visual ecology."

8:25 pm Roger Hardie "Light-sensitive channels in *Drosophila* photoreceptors."

9:10 pm Nicolas Franceschini "Understanding by reconstructing: the use of sighted robots in robotics and physiology."

16 July

Synaptic Mechanisms in the Outer Plexiform Layer

Moderator: Martin Wilson

9:00 am Introduction

9:10 am Don Dixon "Beyond synaptic excitation, metabotropic glutamate receptor actions in horizontal cells"

9:55 am Paul Witkovsky "Gain of Rod to Horizontal Cell Synaptic Transfer."

10:40 am Coffee Break

11:00 am Rukki Rao-Mirotznik "Functional architecture of the rod synapse."

11:45 am Steven Barnes "Plastic photoreceptors: Ion channel modulation."

Talks selected from poster submissions

(20 min talks, 10 min question and answer)

Moderator: Richard Masland

7:30 pm Introduction

7:40 pm Pedro de la Villa "Calcium currents in the axon terminal of mouse bipolar cells, recorded in retinal slice preparation)

8:05 pm Marla Feller "Spatial and temporal properties of spontaneous wave domains in the developing mammalian retina."

8:30 pm Rich Kramer "Cyclic nucleotide-gated channels in synaptic terminals of retinal cone photoreceptors."

8:55 pm Lei Li "Behavioral analysis of visual sensitivity in adult zebrafish."

9:20 pm Stan Schein "Cone ribbon synapses might supply basal synapses with glutamate."

17 July

GABA_C Receptors

Moderator: John Dowling

9:00 am Introduction

9:10 am Ralf Enz "Localization of the GABA_C receptor in the mammalian CNS."

9:55 am Dongxian Zhang "Mechanisms underlying the assembly of functional GABA ρ subunits in oocytes."

10:40 am Coffee Break

11:00 am Haohua Qian "GABA_C receptors in the white perch retina."

11:45 am Tian-Li Wang "GABA ρ receptor: Structure and function."

Synaptic Processes in the Inner Plexiform Layer

Moderator: Aki Kaneko

7:30 pm Introduction

7:40 pm Ruth Heidelberger "ATP and exocytosis at a ribbon synapse."

8:25 pm Martin Wilson "What is a quantum of transmitter?"

9:10 pm Peter Lukasiewicz "AMPA-type glutamate receptors may shape excitatory synaptic inputs to retinal ganglion cells."

18 July

Ecology of Vision

Moderator: Markus Meister

8:30 am Introduction

8:40 am Belinda Chang "Using comparative methods to investigate the evolution of wavelength regulation in visual pigments."

9:25 am Ed Pugh "Double-cones, double-cone mosaics and polarization-difference imaging."

10:10 am Coffee Break

10:30 am Gershon Buchsbaum "Modeling of signal sampling and propagation through multiple retinal cell layers."

11:15 am Sean McCarthy "Preferential representation of natural scenes in the salamander retina."

* Has indicated a possible conflict of interest.

Retinal Neurobiology and Visual Processing

We Gratefully Acknowledge Contributions from the Following Organizations

**FASEB
JEOL USA Inc.
Sutter Instrument
NSF
Avon Instruments, Inc.
U.S. Air Force
ONR**

Recent Papers of the Speakers
(Arranged in alphabetical order for each session)

Visual Performance

Banks

Allen D; Banks MS; Norcia AM . Does chromatic sensitivity develop more slowly than luminance sensitivity? *Vision Research*, 1993, 33:2553-62

Savage GL; Banks MS . Scotopic visual efficiency: constraints by optics, receptor properties, and rod pooling. *Vision Research*, 1992, 32:645-56

Banks MS; Sekuler AB; Anderson SJ . Peripheral spatial vision: limits imposed by optics, photoreceptors, and receptor pooling. *Journal of the Optical Society of America a. Optics and Imagescience*, 1991, 8:1775-87

Brainard

Brainard, D. H. (1995). Reconstructing images from trichromatic samples: from basic research to practical applications.. *Proceedings of the IS&T/SID Color Imaging Conference: Color Science, Systems, and Applications*, Scottsdale, AZ, pp. 4-10.

Williams, D. R., Sekiguchi, N., & Brainard, D. H. (1993). Color, contrast sensitivity, and the cone mosaic. *PNAS USA*, 90, 9770-9777.

Brainard, D. H., & Williams, D. R. (1993). Spatial reconstruction of signals from short wavelength cones. *Vision Research*, 33(1), 105-116.

Reuter

Copenhagen D.R., Hemilä S. and Reuter T. (1990). Signal transmission through the dark-adapted retina of the toad (*Bufo marinus*). Gain, convergence, and signal/noise. *J Gen Physiol* 95: 717-732.

Aho A.-C., Donner K. and Reuter T. (1993). Retinal origins of the temperature effect on absolute visual sensitivity in frogs. *J Physiol* 463: 501-521.

Aho A.-C., Donner K., Helenius S., Olesen Larsen L. and Reuter T. (1993). Visual performance of the toad (*Bufo bufo*) at low light levels: retinal ganglion cell responses and prey-catching accuracy. *J Comp Physiol A* 172: 671-682.

Leibrock C.S., Reuter T. and Lamb T.D. (1994). Dark adaptation of toad rod photoreceptors following small bleaches. *Vision Research* 34: 2787-2800.

Smirnakis

S.M. Smirnakis, M.J. Berry, D. K. Warland, W. Bialek, M. Meister, "Retinal Processing Adapts to Image Contrast and Spatial Scale," (manuscript submitted for publication).

S.M. Smirnakis, M.J. Berry, D. K. Warland, W. Bialek, M. Meister, "Dynamics of Adaptation to Changing Spatial Structure in the Tiger Salamander Retina." Abstract, Twenty-fifth Annual Meeting of the Society for Neuroscience, San Diego, CA, November 1995.

S. M. Smirnakis, D.K. Warland, W. Bialek, M. Meister, "Tiger Salamander Retina Adapts to Temporal Contrast Modulation to Improve Coding Efficiency." Abstract, Association of Research in Vision and Ophthalmology Conference, Fort Lauderdale, FL, May 1995

Signal Transduction and Modulation in On Bipolar Cells

Duvoisin

Duvoisin RM; Zhang C; Ramonell K . A novel metabotropic glutamate receptor expressed in the retina and olfactory bulb. *Journal of Neuroscience*, 1995 Apr, 15:3075-83.

Duvoisin RM; Zhang C; Hamassaki-Britto DE; Britto LR . Changes in expression of glutamate receptor subunits following photoreceptor degeneration in the rd mouse retina. *Neuroscience Letters*, 1995 Jan 2, 183(1-2):83-6.

Pin JP; Duvoisin R. The metabotropic glutamate receptors: structure and functions. *Neuropharmacology*, 1995 Jan, 34(1):1-26.

Britto LR; Rogers SW; Hamassaki-Britto DE; Duvoisin RM . Nicotinic acetylcholine receptors in the ground squirrel retina: localization of the beta 4 subunit by immunohistochemistry and in situ hybridization. *Visual Neuroscience*, 1994, 11:569-77

Frishman

Robson JG, Frishman, LJ. (1995) Response linearity and dynamics of the cat retina: the bipolar cell component of the dark-adapted ERG, *Vis. Neurosci.*, 12: 837-850.

Robson JG, Frishman, LJ. (1996) Photoreceptor and bipolar-cell contributions to the cat electroretinogram: a kinetic model for the early part of the flash response. *J. Opt. Soc. Am. A.*, 13: 613-622.

Frishman, LJ, and Robson, JG. (1996) Inner retinal components of the scotopic ERG of the cat. *J. Brain Res.* 37: 204-205.

Frishman, LJ, Robson, JG and Viswanathan (1996) Response kinetics of retinal cells at scotopic levels in the cat. *Invest. Ophthalmol.* 37: S348.

Nawy

Nawy S; Jahr CE . cGMP-gated conductance in retinal bipolar cells is suppressed by the photoreceptor transmitter. *Neuron*, 1991 Oct, 7(4):677-83.

Nawy S; Jahr CE . Suppression by glutamate of cGMP-activated conductance in retinal bipolar cells. *Nature*, 1990 Jul 19, 346(6281):269-71.

Nawy S; Jahr CE. Time-dependent reduction of glutamate current in retinal bipolar cells. *Neuroscience Letters*, 1990 Jan 22, 108(3):279-83.

Mechanisms and Functions of Gap Junctional Coupling

McMahon

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McMahon, D.G., Rischert, J. C., and Dowling, J.E. (1994) Protein content and cAMP-dependent phosphorylation of fractionated white perch retina. *Brain Res.* 659:110-116.

McMahon, D.G. (1994) Modulation of electrical synaptic transmission in zebrafish retinal horizontal cells. *J. Neurosci.* 14:1722-1734.

Mills

Mills, S.L. and Massey, S.C. (1995) Differential properties of two gap junctional pathways made by AII amacrine cells. *Nature* 77, 734-737.

Mills, S.L. and Massey, S.C. (1994) Distribution and coverage of A- and B-type horizontal cells stained with Neurobiotin in the rabbit retina. *Visual Neuroscience* 11, 549-560.

Schnapf

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Kraft, T.W., Schneeweis, D.M. & Schnapf, J.L. (1993). Visual transduction in human rod photoreceptors. *Journal of Physiology* 464, 747-765.

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Smith

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Smith, R.G. (1995) Simulation of an anatomically-defined local circuit: the cone-horizontal cell network in cat retina. *Visual Neuroscience*, 12: 545-561.

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Insect Vision: Ionic Channels to MachinesFranceschini

Franceschini, N.; Pichon, J.M., Blanes, C. (1992) From insect vision to robot vision *Phil. Trans. Roy. Soc. B* 337, 283-294

Martin, N., Franceschini, N. (1994) Obstacle avoidance and speed control in a mobile vehicle equipped with a compound eye In: 'Intelligent Vehicles', EI. Masaki (Ed.), M.I.T. Press, Cambridge (U.S.A.), pp. 381-386

Mura, F., Franceschini, N. (1994) Visual control of altitude and speed in a flying agent In: 'From Animals to animats', D. Cliff, P. Husbands, J.A. Meyer, S.W. Wilson, M.I.T. Press, Cambridge, U.S.A, pp. 91-99

Mura, F., Martin, N., Franceschini (1996) Biologically inspired eye movements for the visually-guided navigation of mobile robots In: 'Proc. 4th European Symposium on Artificial Neural networks', ESANN 96, Bruges, Belgium, M. Verleysen (Ed.), D-Facto, Brussels, pp. 135-147

Hardie

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Laughlin

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Synaptic Mechanisms in the Outer Plexiform Layer

Barnes

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Dixon

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Rao-Mirotznik

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Rao-Mirotznik, R., A. B. Harkins, G. Buchsbaum, and P. Sterling. (1995) Mammalian rod terminal: architecture of a binary synapse. *Neuron* 14:561-569.

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Witkovsky

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Krizaj, D., Akopian, A., and Witkovsky, P. 1994. The effects of L-glutamate, AMPA, quisqualate and kainate on retinal horizontal cells depend on adaptational state: implications for rod-cone interactions. *J. Neurosci.* 14:5661-5671

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GABA_A Receptors

Enz

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Qian

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Wang

T. Kusama, T-L Wang, W B Guggino, G R Cutting, and G R Uhl (1993) GABA r2 receptor pharmacological profile: GABA recognition site similarities to r1. *Eur. J Pharmacology*, 245: 83-84

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Zhang

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Synaptic Processes in the Inner Plexiform Layer

Heidelberger

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Buchsbaum

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PARTICIPANT LIST ** Conference : 6 -- Retinal Neurobio/Visual Proc
FASEB SUMMER RESEARCH CONFERENCES

Dr. Pamela Abshire
Electrical/Computer Eng
The Johns Hopkins University
226 Barton Hall 3400 N Charles
Baltimore MD 21218
410-516-8361
410-516-5566
pamela@olympus.ece.jhu.edu

Dr. Alan R. Adolph
Scientific Communications
Schepens Eye Res Inst/Harvard
20 Staniford St
Boston MA 02115
617-742-3140 x 250
617-227-3577
ara@vision.eri.harvard.edu

Dr. Abram Akopian
Ophthalmology
New York Univ Med Ctr
550 First Ave
New York NY 11415
212-263-7603
212-263-7602
Akopian@is4.nyu.edu

Dr. Meredith Applebury
Ophthalmology
Harvard Med School / MEEI
243 Charles St Room 550
Boston MA 02114
617-573-4373
617-573-3751
mapplebury@meei.harvard.edu

Dr. Rosario M. Balboa
Universidad de Alicante and
Smith Kettlewell Inst
2232 Webster St
San Francisco CA 94115
415-561-1740
415-561-1610
rbalboa@s04.eps.ua.es

Dr. William H. Baldrige
Medical Physiology
Univ of Calgary
3330 Hospital Dr NW
Calgary AB T2N 4N1
CANADA
403-220-5012
403-283-8731
baldredw@acs.ucalgary.ca

Dr. Martin Banks
Sch of Optometry
Univ of California/Berkeley
Berkeley CA 94720-0220
510-842-7679
marty@john.berkeley.edu

Dr. Robert Barlow
Ophthalmology Department
SUNY Health Science Center
750 Adams Street
Syracuse NY 13210
315-464-5253
314-464-6663

Dr. Steven Barnes
Medical Physiology
University of Calgary
3330 Hospital Dr NW
Calgary AB T2N 4N1
CANADA
403-220-6221
403-283-8731
sbarnes@acs.ucalgary.ca

Dr. William Beaudot
Bio-inspired Systems Res
CSEM SA
Jaquet-Droz 1
Neuchatel CH 2007
SWITZERLAND
41-38 205 666
41-38 205 763
william.beudot@csemne.ch

Mark Bieda
Department of Ophthalmology
UCSF
10 Kirkham St/Box 0730
San Francisco CA 94143
415-476-3171
415-476-6289
mbieda@waldron.stanford.edu

Brian B. Boycott
Anatomy & Cell Biology
UMDS Guy's Hospital Med Sch
London Bridge
London SW16 3DP
UNITED KINGDOM
44-0171-955-2991
44-0171-955-4915

Dr. David Brainard
Psychology
Univ California/Santa Barbara
Psychology Bldg
Santa Barbara CA 93106
805-893-2011
805-893-4303
brainard@psych.ucsb.edu

Dr. Susan E Brockerhaoff
Molecular & Cell Biology
Harvard University
16 Divinity Ave
Cambridge MA 02138
617-495-2599
617-495-3321
sbrocker@fas.harvard.edu

Solange Brown
Program in Neuroscience
Harvard Univ
Wellman 429/Mass Gen Hospital
Boston MA 02114
617-726-6927
617-726-5336
browns@helix.mgh.harvard.edu

PARTICIPANT LIST ** Conference : 6 -- Retinal Neurobio/Visual Proc
FASEB SUMMER RESEARCH CONFERENCES

Dr. Gershon Buchsbaum
Bioengineering
Univ of Pennsylvania
220 S 33rd St
Philadelphia PA 19104-6392
215-898-5767
215-573-2071
gershon@eniac.seas.upenn.edu

Dr. Mary E. Carwile
Physiology & Biophysics
Univ of Alabama at Birmingham
330 Main St #D67
Gardendale AL 35071
205-325-8651
205-325-8679
carwile@vision.vsrc.uab.edu

Dr. Belinda Chang
Biological Labs
Harvard Univ
16 Divinity Ave
Cambridge MA 02138
617-495-4012
617-495-5667
chang@mcz.harvard.edu

Dr. Richard L. Chappell
Biological Sciences
Hunter Coll/CUNY
695 Par Ave
New York NY 10021
212-772-5294
212-772-5227
rlchc@cunyvm.cuny.edu

Dr. Paul B. Cook
Physiology
Univ of Michigan
7757 Medical Sci II
Ann Arbor MI 48109-0622
313-764-3717
313-936-8813
pcook@umich.edu

Dr. David Copenhagen
Department of Ophthalmology
Univ California/San Francisco
Box 0730
San Francisco CA 94143-0730
415-476-2527
415-476-6289
cope@phy.ucsf.edu

Dr. M. Carter Cornwall
Dept of Physiology
Boston Univ Sch of Med
80 E Concord St
Boston MA 02118
617-638-4256
617-638-4273
cornwall@acs.bu.edu

Dr. Robert D. DeVoe
School of Optometry
Indiana University
800 E Atwater
Bloomington IN 47405
812-855-2861
812-855-7045
devoe@indiana.edu

Dr. Don Dixon
Dept of Pharmacology
University College
Gower St
London WC1 E6BT
UNITED KINGDOM
44-0171-387-7050
44-0171-380-7298
uclddb@ucl.ac.uk

Dr. John E. Dowling
Molecular and Cellular Biol
Harvard Univ
16 Divinity Ave
Cambridge MA 02138
617-495-2245
617-496-3321
Dowling@FAS.Harvard.Edu

Dr. Robert Duvoisin
Dyson Vision Res Inst
Cornell Univ Med Coll
1300 York Ave/Box FB35
New York NY 10021
212-746-2326
212-746-8101
duvoisin@med.cornell.edu

Dr. William D. Eldred
Biology
Boston Univ
5 Cummington St
Boston MA 02215
617-353-2439
617-353-6340
eldred@bio.bu.edu

Dr. Ralf Enz
CMSC 9-120
Johns Hopkins Hosp
600 N Wolfe St
Baltimore MD 21287-3914
410-614-0211
410-614-2620

Dr. Gordon L. Fain
Physiological Sci/Ophthalmolog
Univ California/Los Angeles
Life Sciences 3836
Los Angeles CA 90095-1527
310-206-4281
310-825-4067
gordonf@physci.lifesci.ucla.edu
u

Dr. Andreas Feigenspan
Neurobiology
Harvard Med Sch
220 Longwood Ave
Boston MA 02115
617-432-0225
617-734-7557
andreasf@warren.med.harvard.edu
u

PARTICIPANT LIST ** Conference : 6 -- Retinal Neurobio/Visual Proc
FASEB SUMMER RESEARCH CONFERENCES

Dr. Marla Feller
Molecular & Cell Biology
Univ of California/Berkeley
221 Life Sciences Addition
Berkeley CA 94107
510-643-5769
510-643-5624
marla@violet.berkeley.edu

Dr. Warren Finn
Pharmacology/Physiology
Oklahoma State University
1111 W 17th St Osteopathic Med
Tulsa OK 74107
918-561-8262
918-561-8412
finn@vms.ocom.okstate.edu

Dr. Micolás Franceschini
Neurocybernetique LNB3
CNRS
31 Chemin Joseph Aiguier
Marseille Cdx 20 13402
FRANCE
33-91 16 41 29
33-91 22 08 75
enfranceschini@irlnb.cnrs-mrs.
fr

Dr. Michael A. Freed
Department of Neuroscience
Univ of Pennsylvania
123 Anatomy-Chemistry Bldg
Philadelphia PA 19104-6058
215-573-3211
215-899-9871
michael@retina.anatomy.upenn.
edu

Dr. Laura Frishman
College of Optometry
University of Houston
4901 Calhoun Rd
Houston TX 77204-6502
713-743-1972
713-743-2053
lfrishman@uh.edu

Dr. Daniel G. Green
Ophthalmology
Univ of Michigan
Neuroscience Bldg
Ann Arbor MI 48104
313-763-3457
313-936-2690
dgg@umich.edu

Andrew Grumet
Electrical Eng/Comp Science
Massachusetts Inst Technology
77 Massachusetts Ave Rm 36-576
Cambridge MA 02139
617-253-9834
617-258-7864
agrumet@mit.edu

Dr. Norberto Grzywacz
Smith-Kettlewell Eye Res Inst
2232 Webster St
San Francisco CA 94115
415-561-1795
415-561-1610
nmg@skivv.ski.org

Dr. Abigail Hackam
Pediatrics
The Johns Hopkins University
600 N Wolfe St CMSC 9-120
Baltimore MD 21287
410-614-0211
410-955-0484
ahackam@welchlink.welch.jhu.
edu

Dr. Roger Hardie
Anatomy
Cambridge University
Downing St
Cambridge CB2 3DY
UNITED KINGDOM
44-1223-333771
44-1223-333786
rch14@hermes.cam.ac.uk

Dr. Ruth Heidelberger
Neurobiology & Anatomy
University of Texas Med School
6431 Fannin St Suite 7046
Houston TX 77030
reeidel@gwdgvl.dnet.gwdg.de

Dr. Arlene Hirano
Ophthalmology/Dyson Vision Ins
Cornell Univ Med Coll
1300 York Ave
New York NY 10021
212-746-2234
212-746-8101
hirano@mail.med.cornell.edu

Dr. Peter F. Hitchcock
Ophthalmology/Kellogg Eye Ctr
University of Michigan
1000 Wall Street/Rm 418
Ann Arbor MI 48105
313-936-9547
313-747-0228
peterh@umich.edu

Dr. Eric P. Hornstein
Vision Science/Sch Optometry
Univ of California/Berkeley
360 Minor Hall
Berkeley CA 94720-2020
510-642-2966
510-643-5109
ehorn@mindseye.berkeley.edu

Dr. Karl-Heinz Huemer
General Comparative Physiology
University of Vienna
Schwarzspanierstrasse 17
Vienna A-1090
AUSTRIA
43 1 40 48 0396
43 1 40 48 04 28
huenkal@vm.akh-wien.ac.at

PARTICIPANT LIST ** Conference : 6 -- Retinal Neurobio/Visual Proc
FASEB SUMMER RESEARCH CONFERENCES

Dr. Thomas Hughes
Ophthalmology/Visual Sci
Yale Med Sch
330 Cedar St/PO Box 208061
New Haven CT 06520
203-737-4444
203-785-7401
tom.hughes@qm.yale.edu

Thomas Hwang
Dept of Ophthalmology
Univ of California
10 Kirkham St/Rm K140
San Francisco CA 94143-0730
415-476-3171
415-476-6289
thwang@itsa.ucsf.edu

Roy A. Jacoby
Neurobiology and Anatomy
Univ of Texas/Houston Med Sch
6431 Fannin St
Houston TX 77030
713-792-5706
713-792-5795
rjacoby@nba19.med.uth.tms.edu

Dr. Jeffrey A. Jamison
Ophthalmology
Kellogg Eye Ctr
1000 Wall St
Ann Arbor MI 48105
313-763-8189
jeffj@umich.edu

Dr. Makoto Kaneda
Physiology
Keio Univ Sch of Medicine
Shinanomachi 35
Tokyo 160
JAPAN
81-3-3353-1211x2615
81-3-3359-0437

Dr. Akimichi Kaneko
Physiology
Keio Univ School of Med
35 Shinano-machi/Shinjuku-ko
Tokyo 160
JAPAN
81-3-3359-0437
81-3-3359-0437
kaneko@dmf.med.keio.ac.jp

Dr. Ehud Kaplan
Ophthalmology
The Mount Sinai Sch of Med
One Gustave Levy Place
New York NY 10029
212-241-9607
212-289-5945
kaplane@rockvax.rockefeller.edu

Dr. Richard H. Kramer
Molecular & Cellular Pharmacol
Univ of Miami Sch of Med
PO Box 016189
Miami FL 33101
305-243-6612
305-243-4555
rkramer@me.jnet.med.miami.edu

Dr. David Krizaj
Ophthalmology/Physiology
University of California
10 Kirkham St/Rm K-137
San Francisco CA 94143-0730
415-476-3171
415-476-6289
krizaj@phy.ucsf.edu

Dr. Abner B. Lall
Biological Laboratories
Harvard University
16 Divinity Ave
Cambridge MA 02138
617-495-2599
617-495-3321
ablall@fas.harvard.edu

Dr. Simon Laughlin
Zoology
Univ of Cambridge
Downing St
Cambridge CB2 3EJ
UNITED KINGDOM
44-1223 336609
44-1223 336676
sl104@cam.ac.uk

Dr. Lei Li
Molecular & Cellular Biol
Harvard Univ
16 Divinity Ave
Cambridge MA 02138
617-495-2599
617-495-3321
leili@husc.harvard.edu

Dr. Peter Lukasiewicz
Ophthalmology & Visual Science
Washington Univ Sch of Med
660 S Euclid Ave/Box 8096
St Louis MO 63110
314-362-4284
314-362-3638
lukasiewicz@am.seer.wustl.edu

Dr. Stuart Mangel
Neurobiology Res Ctr
Univ of Alabama/Birmingham
1719 6th Ave South - CIRC 425
Birmingham AL 35294
205-975-5095
205-934-6571
mangel@nrc.uab.edu

Dr. Richard H. Masland
HHMI
Massachusetts Gen Hosp
55 Fruit St/Wellman 429
Boston MA 02114
617-726-3888
617-726-5336
masland@helix.mgh.harvard.edu

PARTICIPANT LIST ** Conference : 6 -- Retinal Neurobio/Visual Proc
FASEB SUMMER RESEARCH CONFERENCES

Dr. Steve Massey
Ophthalmology - Visual Science
University of Texas
6431 Fannin Suite 7024
Houston TX 77030
713-745-3221
713-792-4573
smassey@gsbs.gs.uth.tmc.edu

Dr. Sean McCarthy
Molecular & Cell Biology
Univ of California/Berkeley
181 Life Science Annex
Berkeley CA 94720-3200
510-842-9189
510-843-6791
seanmc@uclink.berkeley.edu

Dr. Douglas G. McMahon
Physiology 0084
Univ of Kentucky
Ms570 A B Chandler Med Ctr
Lexington KY 40536-0084
606-323-1070
mcmahond@uklans.uu.edu

Dr. John S. McReynolds
Department of Physiology
University of Michigan
1150 W. Med Center Drive
Ann Arbor MI 48109-0622
313-763-2559
313-936-8813
jsm@umich.edu

Dr. Markus Meister
MCB Department
Harvard University
16 Divinity Ave
Cambridge MA 02138
617-496-8301
617-495-9300
meistr@biosun.harvard.edu

Dr. William H. Miller
Ophthalmology
Yale Med Sch
PO Box 208061
New Haven CT 06520
203-785-4955
203-785-6123

Dr. Stephen L. Mills
Ophthalmology & Visual Sciences
University of Texas - HSC
Houston TX 77030
713-792-8650
713-792-4513
smills@gsbs.gs.uth.tmc.edu

Dr. Rukmini Rao Mirotznic
Synaptic Mechanisms Sect
NINDS/NIH
Bldg 36 Rm 5A16
Bethesda MD 20892
301-496-8220
301-496-8678
rukki@codon.nih.gov

Dr. Katsuko Morigiwa
Physiology
Osaka University Medical Sch
2-2 Yamadaoka
Suita 565
JAPAN
81-6-879-3612
81-6-879-3619
km@phys2.med.osaka.uac.jp

Dr. Frank Mueller
Inst Biolog Information Proces
Research Ctr Juelich
Leo Brnadt Strasse
Juelich D-52425
GERMANY
49-2461-613661
49-2461-614216
Mueller@IB1.1B1.kFA-Juelich.DE

Karen L. Myhr
Department of Physiology
University of Michigan
1301 E Catherine Street
Ann Arbor MI 48109-0622
313-764-3717
313-764-3813
kjl@umich.edu

Dr. Scott Nawy
Ophthalmology & Visual Sci
Albert Einstein Coll of Med
1300 Morris Park Rd/Rm 525K
Bronx NY 10461
212-430-2485
212-430-2199
nawy@uecom.yu.edu

Dr. Ralph F. Nelson
Lab of Neurophysiology
NINDS/NIH
Bldg 36 Rm 2C-02 MSC 4066
Bethesda MD 20892-4066
301-496-8133
301-402-1565
rnelson@codon.nih.gov

Dr. Sheila Nirenberg
Molecular & Cellular Biology
Harvard University
16 Divinity Ave
Cambridge MA 02138
617-496-8302
617-495-9300
sheila@rhino.harvard.edu

Dr. Zhuo-Hua Pan
Neurology
Children's Hosp/Harvard Med Sc
300 Longwood Ave/Enders 348
Boston MA 02115
617-355-6443
617-730-0636
PAN@AI.TCH.HARVARD.EDU

PARTICIPANT LIST ** Conference : 6 -- Retinal Neurobio/Visual Proc
FASER SUMMER RESEARCH CONFERENCES

Dr. Renate Pflug
General & Comparative Physiol
Univ of Vienna
Schwarzspanierstr.17
Vienna 1090
AUSTRIA
43-1-40480-235
43-1-40480-428
RENATE.PFLUG@UNIVIE.AC.AT

Dr. Joel Pokorny
Ophthalmology & Visual Science
University of Chicago
939 East 57th Street
Chicago IL 60637
312-702-1983
312-702-4442
s+p@chroma.uchicago.edu

Dr. Edward Pugh
Psychology
Univ of Pennsylvania
3815 Walnut St
Philadelphia PA 19104
215-898-7524
215-573-3892

Dr. Haohua Qian
Molecular & Cellular Biology
Harvard Univ
16 Divinity Ave
Cambridge MA 02138
617-495-2599
617-496-3221
hqian@fas.harvard.edu

Herbert Reitsamer
General & Comparative Physiol
Univ of Vienna
Schwarzspanierstr 17
Vienna 1090
AUSTRIA
43-1-40480-235
43-1-40480-428
A5141GAC2VM.UNIVIE.AC.AT

Dr. Thomas Reuter
Dept Ecology & Systematics
Univ of Helsinki-Zoology Lab
Arkadiankatu 7
Helsinki 10 SF 00100
FINLAND
358-4027200
358-0 1917301
Tom.Reuter@Helsinki.Fi

Dr. Fred Rieke
Neurobiology
Stanford University
Fairchild D-238
Palo Alto CA 94305
415-723-7556
415-725-3958
riekel@leland.stanford.edu

Dr. John Robson
Physiology Lab
Univ of Cambridge
Cambridge CB2 3EC
UNITED KINGDOM
44-1223 333878
44-1223 333840
jgr11@cus.cam.ac.uk

Dr. Botond M. Roska
Molec & Cell Biology/Neurobiol
Univ of California/Berkeley
145 LSA/MCB
Berkeley CA 94720
510-642-9760
510-643-6791
botond@mander.berkeley.edu

Dr. Michael E. Rudd
Psychology
Johns Hopkins Univ
3400 N Charles St
Baltimore MD 21218-2686
410-516-5228
410-516-4478
rudd@troland.psy.jhu.edu

Dr. William M. Saidel
Biology
Rutgers Univ
3rd and Penn S
Camden NJ 08102
609-225-6336
609-225-6312
saidel@crab.rutgers.edu

Dr. Stan Schein
Psychology
Univ California Los Angeles
Franz Hall
Los Angeles CA 90095-1563
310-825-0505
310-206-5895
stan@psych.ucla.edu

Dr. Yvonne Schmitz
Ophthalmology
NYU Med Ctr
550 First Ave
New York NY 10016
212-263-7603
212-263-7602
schmitzy@is2.nyu.edu

Dr. Julie Schnapf
Ophthalmology
Univ California/San Francisco
Box 0730
San Francisco CA 94143
415-476-6758
415-476-6289
schn@phy.ucsf.edu

Dr. David Schneeweis
Ophthalmology
Univ California/San Francisco
10 Kirkham St/Rm K-230
San Francisco CA 94143
415-476-6097
415-476-6289
schnee@itsa.ucsf.edu

PARTICIPANT LIST ** Conference : 6 -- Retinal Neurobio/Visual Proc
FASEB SUMMER RESEARCH CONFERENCES

Dr. Wen Shen
Biophysical Sci
SUNY/Buffalo
110 Cory Hall/South Campus
Buffalo NY 14214
716-829-3240
716-829-3240
wenshen@ubvms.cc.buffalo.edu

Colleen R. Shields
Neuroscience
Washington Univ
Box 8108 Anatomy & Neurobiol
St Louis MO 63110
314-362-4870
314-747-1150
shields@thalamus.wustl.edu

Dr. Robert Smith
Department of Neuroscience
Univ of Pennsylvania
Rm 123 Anatomy/Chemistry Bldg
Philadelphia PA 19104-6058
215-573-3211
215-898-9871
rob@retina.anatomy.upenn.edu

Dr. Vivianne Smith
Ophthalmology & Visual Science
University of Chicago
939 East 57th Street
Chicago IL 60637
312-702-1983
312-702-4442
s+p@chroma.uchicago.edu

Dr. Erik Sobel
Neurosurgery Res
Massachusetts General Hosp
50 Blossom St/Wellman Rm 429
Boston MA 02114
617-724-7775
617-726-5336
sobel@helix.mgh.harvard.edu

Dr. Peter Sterling
Neuroscience
Univ of Pennsylvania
Pennsylvania PA 19104
215-898-9228
215-898-9871
peter@retina.anatomy.upenn.edu

Dr. Ann E. Stuart
Physiology
Univ of North Carolina
Chapel Hill NC 27599-7545
919-966-1273
919-966-6927
stuart@med.unc.edu

Dr. Wallace B. Thoreson
Ophthalmology
Univ of Nebraska Med Ctr
600 S 42nd St
Omaha NE 68198-5540
402-559-8941
402-559-5514
wbthores@unmc.edu

Dr. Ning Tian
Ophthalmology
Univ of California/San Fran
10 Kirkham St/Rm K-140
San Francisco CA 94131
415-476-3171
415-476-6289
tian@itsa.ucsf.edu

Dr. Yoshihiko Tsukamoto
Anatomy and Neuroscience
Hyogo College of Medicine
1-1 Mukogawa
Nishinomiya 663
JAPAN
798-45-6416
798-45-6417
d63126@center.osaka-u.ac.jp

Dr. Anne Vallet
Physiology
Univ Conn Health Center
263 Farmington Ave
Farmington CT 06030
203-697-2747
203-697-1269
Vallet@nsol.uhc.edu

Dr. Noga Vardi
Department of Neuroscience
Univ of Pennsylvania
123 Anatomy/Chemistry Bldg
Philadelphia PA 19104-6058
215-898-4520
215-898-9871
noga@retina.anatomy.upenn.edu

Dr. Toby J. Velte
HHMI
Massachusetts Gen Hosp
Fruit St/429 Wellman
Boston MA 02114
617-724-0073
617-726-5336
velte@helix.mgh.harvard.edu

Suresh Viswanathan
College of Optometry
Univ of Houston
Calhoun Rd
Houston TX 77204
713-743-1997
713-743-2053
ST2DT@JETSON.UH.EDU

Dr. Tian-Li Wang
Neuroscience
Univ of Pennsylvania
123 Anatomy/Chemistry Bldg
Philadelphia PA 19104-6058
215-898-9228
215-898-9871
tlw@retina.anatomy.upenn.edu

PARTICIPANT LIST ** Conference : 6 -- Retinal Neurobio/Visual Proc
FASEB SUMMER RESEARCH CONFERENCES

Dr. Reto Weiler
Neurobiology
Univ of Oldenburg
PO Box 2503
Oldenburg 26111
GERMANY
49-441-7982581
49-441-7983423
weiler@biologie.uoi-oldenburg.
de

Dr. David Wellis
Neurobiology-Molec & Cell Biol
Univ California at Berkely
Life Sciences Addition 145
Berkely CA 94720
510-642-9750
510-643-6791
david@mander.berkely.edu

Dr. Frank S. Werblin
Neurobiology
Univ of California/Berkeley
145 Isa
Berkeley CA 94720
510-642-7236
510-643-9424
werblin@mander.berkeley.edu

Dr. Eric M. Wexler
Ophthalmology/Kennedy Ct/Rm525
Albert Einstein Coll of Med
1410 Pelham Parkway South
Bronx NY 10461
718-430-2485
718-430-8821
ewexler@aecom.yu.edu

Dr. Martin Wilson
Neurobiol/Physiol/Behavior
Univ of California/Davis
Div of Biological Sci
Davis CA 95616-8519
916-752-7250
mcwilson@ucdavis.edu

Dr. Paul Witkovsky
Ophthalmology
New York Univ Med Ctr
550 First Ave
New York NY 10016
212-263-6488
212-263-7602
witkovsky@152.nyu.edu

Dr. Dongxian Zhang
Neurology Enders 361
Childrens Hosp/Harvard Med Sch
300 Longwood Ave
Boston MA 02115-5737
617-355-6289
617-730-0636
zhang_d@al.tch.harvard.edu

Dr. Anita Zimmerman
Physiology
Brown University
Box G-B329
Providence RI 02912
401-863-2224
401-863-1222
Anita_Zimmerman@Brown.edu

Dr. Charles L. Zucker
Neuroscience
Schepens Eye Res Inst
20 Staniford St
Boston MA 02114
617-742-3140 x 485
617-720-1069
zucker@vision.eri.harvard.edu

Dr. Pedro de la Villa
Physiology & Pharmacology
Univ Alcalá de Henares
Campus Universitario
Alcalá de Henares E-28871
SPAIN
34-1885 4522
34-1885 4525
ffvilla@alcala.es

Dr. Mark van Rossum
Neuroscience
Univ of Pennsylvania
Rm 123 Anatomy/Chem Bldg
Philadelphia PA 19143
215-898-7536
215-898-9871

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