

**CURRICULUM VITAE**  
**HILLEL J. CHIEL, Ph.D.**

Department of Biology  
2080 Adelbert Road  
Case Western Reserve University  
Cleveland, OH 44106 - 7080

(216) 368-3846

**EMPLOYMENT**

1999 - present	<b>Professor</b>	<i>Department of Biology College of Arts and Sciences Case Western Reserve University</i>
1999 - present	<b>Professor</b>	<i>Department of Neuroscience School of Medicine Case Western Reserve University</i>
1999 - present	<b>Professor</b>	<i>Department of Biomedical Engineering Case School of Engineering Case Western Reserve University</i>
1992 - 1999	<b>Associate Professor</b>	<i>Department of Neuroscience Case Western Reserve University</i>
1992 - 1999	<b>Associate Professor</b>	<i>Department of Biology Case Western Reserve University</i>
1989 - 1992	<b>Assistant Professor</b>	<i>Department of Neuroscience, Case Western Reserve University</i>
1987 - 1992	<b>Assistant Professor</b>	<i>Department of Biology, Case Western Reserve University</i>
1985 - 1987	<b>Consultant in Neurobiology</b>	<i>Department of Molecular Biophysics AT&amp;T Bell Laboratories Murray Hill, NJ 07974.</i>
1980 - 1985	<b>Postdoctoral Fellow</b>	<i>Center for Neurobiology and Behavior Columbia University's College of Physicians and Surgeons New York, NY 10032.</i>

**EDUCATION**

1980	M.I.T.	Ph.D.	Neural and Endocrine Regulation
1976	M.I.T.	M.S.	Nutrition and Metabolism
1974	Yale University	B.A.	English

**HONORS AND AWARDS**

2004            Elected a Fellow of the Institute of Physics, London, England

Hillel J. Chiel, Ph.D.

2004 Wittke Award for Excellence in Undergraduate Teaching  
2004 Undergraduate Teaching Excellence Award in Engineering  
1998 Undergraduate Teaching Excellence Award in Mathematics and Natural Sciences  
1997 Hewlett Award for an Innovative Teaching Initiative  
1995 Best Video Award for video entitled "Biologically-Inspired Hexapod Robot Project: Second Robot", 1995 IEEE International Conference on Robotics and Automation  
1991 Creativity Extension on NSF grant  
1989 - 1992 George B. Mayer Assistant Professorship  
1989 Sigma Xi Research Award for Faculty  
1988 Award for Excellence, University Office of Undergraduate Affairs  
1981 NIMH National Research Award  
1980 Election to membership in Sigma Xi, M.I.T. Chapter  
1971 Benjamin F. Barge Prize in Mathematics, Yale University

## MEMBERSHIPS

Society for Neuroscience  
International Society for Neuroethology  
Mathematical Association of America  
American Association for the Advancement of Science

## RESEARCH GRANTS

Principal Investigator, **Neuromechanics of Multifunctionality in *Aplysia***, NIH, 02/14/05 – 02/13/10, \$1,769,065 (total).

Principal Investigator, **Collaborative Research in Computational Neuroscience (CRCNS): Dynamics and Plasticity of a Neuromechanical System**, NSF, 08/15/02 – 08/14/05, \$800,000 (total).

Co-Principal Investigator, **Optical Control of a Rhodopsin-Based Switch**, Ohio Board of Regents, \$75,580 (total).

Co-Principal Investigator, **Reconfigurable and Multifunctional Behavioral Pattern Generators**, NSF, 6/1/2002 - 5/31/2004, \$399,035 (total).

Principal Investigator, **Neuromechanics of a Muscular Hydrostatic Manipulator**, CWRU Presidential Research Initiative Grant, 1/01/2001 - 12/31/2002, \$50,000 (total)

Principal Investigator, **Neural Control of a Context-Dependent Molluscan Feeding Muscle**, NSF, 9/15/1999- 9/14/2002, \$371,431 (total).

Principal Investigator, **Neural Basis of Multifunctionality in the Feeding Behavior of *Aplysia***, Whitehall Foundation, 7/1/1997 - 6/30/2000, \$117,088 (direct), \$2,912 (indirect), \$120,000 (total).

Principal Investigator, **Dynamics of Biological Systems: A Proposal to Create a New Course**, UCITE, 7/1/2000 - 6/30/2001, \$10,000.

Core Faculty, **Integrative Graduate Education and Research Training in Neuromechanical Systems**, NSF, 8/1/1999 - 7/31/2004, \$2,629,105, Drs. Roy Ritzmann and Pat Crago, co-PIs.

Co-Principal Investigator, **Autonomous Robotics Program**, Parker Hannifin, Dr. Randall Beer, P.I., 9/1/200- 8/31/200, \$10,000.

Co-Principal Investigator, **Autonomous Robotics Course**, The Case Alumni Association, Dr. Randall Beer, P.I., 6/15/97 - 6/14/98, \$27,300 (total).

Investigator, **Learning and Intelligent Systems: Agile Procedural Learning Systems**, NSF, Dr. Randall Beer, P.I., 9/1/1997 - 8/31/2000, \$775,000 (total).

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Co-Principal Investigator, **A Cockroach-Like Hexapod Robot for Natural Terrain Locomotion**, Office of Naval Research, Dr. Randall Beer, P.I., 1/1/1996 - 12/31/1998, \$397,620 (direct), \$202,380 (indirect), \$600,000 (total).

Co-Principal Investigator, **Locomotion Controller for Walking Machines for Shallow Underwater Operations**, Subcontract from K<sup>2</sup>T (Duquesne, PA) through SBIR from Office of Naval Research, 1995 - 97, \$150,000.

Co-Principal Investigator, **Locomotion Controller for Walking Robots for Clearance of Improved Conventional Munitions**, Subcontract from K<sup>2</sup>T (Duquesne, PA) through Office of Naval Research, 1995-98, \$317,000.

Principal Investigator, **Neural Networks for Adaptive Behavior**, NSF Grant IBN-9309691. 8/15/1993 - 8/14/1995, \$95,426 (direct), \$48,667 (indirect), \$144, 093 (total).

Principal Investigator, **Neural Network Control of Quasi-Rhythmic Behavior**, Project 1 of NIH Program Project Grant, Dr. Neil Cherniack, P.I. 4/1/91 - 3/31/96, \$509,427 (direct), \$224,512 (indirect), \$733,939 (total for Project 1).

Co-Principal Investigator, **A Biologically-Inspired Autonomous Robot**, Office of Naval Research (3 year extension of grant N00014-90-J-1545), Dr. Randall Beer, P.I., 1/1/1993 - 12/31/1996, \$429,880 (direct), \$214,139 (indirect), \$644,019 (total).

Co-Principal Investigator, **Undergraduate Biological Sciences Educational Initiative**, Howard Hughes Medical Institute, Dr. Norman B. Rushforth, P.I., 9/1/1994 - 8/31/1998, \$2,000,000 (total).

Co-Principal Investigator, **Central Pattern Generators for *Aplysia* Feeding**, United States - Israel Binational Science Foundation, 93-00224, Dr. Abraham Susswein, P.I., 8/1/1994 - 7/31/1997, \$100,500 (total).

Principal Investigator, **Pattern Generation in Neural Networks**, NSF Grant BNS88-10757. 8/1/1988-7/31/1993, \$356,163 (direct), \$144,211 (indirect), \$500,374 (total).

Co-Principal Investigator, **Neural Networks for Real-Time Sensory Data Processing and Sensorimotor Control**, Office of Naval Research (N00014-90-J-1545), Dr. Randall Beer, P.I. 1990 - 1993, \$250,564 (direct), \$89,436 (indirect), \$340,000 (total).

Co-principal Investigator, **Instrumentation for a Modern Undergraduate Neurobiology Laboratory**, NSF. 1990-1991, Dr. Roy Ritzmann, P.I., \$74,788 (total).

Principal Investigator, **Neuronal Computation in Simpler Nervous Systems and Circuits**, Research Initiation Grant, Ohio Board of Regents, 1987-1988, \$5000.

## PATENTS

**Neural-based Autonomous Robotic System**, R. D. Beer, H. J. Chiel and L. S. Sterling; patent number 5,124,918, 6/23/1992.

**Peristaltically Self-Propelled Endoscopic Device**, H. J. Chiel, R. D. Quinn, R. D. Beer, and E. V. Mangan; patent number 6,764,441, 7/20/2004.

## EDUCATIONAL EXPERIENCE

1988 - present (Fall)	Designed and taught course, <b>Introduction to Neurobiology</b> (BIOL 373/473; NEUR 473)
1988 (Spring)	Lecturer, <b>Associative Neural Networks for Computing</b> (EEAP 396/496)
1988 - 1991 (Fall)	Led Freshman Seminar, <b>How the Brain Works</b>
1989 - present (Spring)	Designed and taught course, <b>Neurobiology Laboratory</b> (BIOL 376/476)
1990 - present (Fall)	Lecturer, <b>Systems Neuroscience</b> (NEUR 406)
1990 - present (Spring)	Designed and taught course, <b>Computational Neuroscience</b> (BIOL

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378/478); taught in alternate years  
1990 - present (Spring) Lecturer, **Cell and Molecular Neurobiology**, (NEUR 405)  
1991 - present (Spring) Designed and taught course, **Seminar in Computational Neuroscience** (BIOL 379); taught in alternate years  
1991 - 1993 (Fall) Led Freshman Seminar, **Life's Designs**  
1995 - present Designed and taught course, **Autonomous Robotics** (BIOL 375, 475); taught in both Fall and Spring semesters  
2000 - present Designed and taught course, **Dynamics of Biological Systems** (BIOL 300/EBME 300); currently taught in both Fall and Spring semesters.  
2000 - present Designed and taught course, **Dynamics of Adaptive Behavior** (BIOL 477/ECES 477); taught in alternative years

## SERVICE

1987 - 1991 Member, Curriculum Committee, Faculty of Mathematics and Natural Sciences  
1989 - present Member, Steering Committee for CWRU's grant from the Howard Hughes Medical Institute for its Undergraduate Biological Sciences Educational Initiative  
1990 - 1991 Member, Curriculum Committee of the General Faculty of the Colleges  
1990 - present Science Consultant, Private Day School in University Heights (Bet Sefer Mizrahi); member of its Education Committee, Judge of Science Fair, responsible for special science presentations; Chairman of Science Committee; Education Vice-President 1997 - 1998; received Education Leadership Award in 1999; Chair of Head Support and Evaluation Committee, 2000 - present  
1992 - 1993 Member, Search Advisory Committee to select Dean of College of Arts and Sciences  
1992 - 1993 Member, Planning Committee for Renewal Grant to Howard Hughes Medical Institute Undergraduate Biological Sciences Educational Initiative  
1994 - 2000 Co-chair, Curriculum Enhancement Committee  
1996 - present Panel for Hearing Procedures  
1997 - 1998 Member, Provost's Search Committee for a BME faculty member in electrophysiology of neurons and neural networks  
1999 - 2000 Member, President's Advisory Committee for Promotion and Tenure in the School of Dentistry  
2000 - 2001 Member, Search committee for Neuromechanics faculty member in Department of Biology  
2002 - 2003 Member, Search committee for Theoretical Biology faculty member in Department of Biology  
2003 Member, Committee on the Future of Information Technology at CWRU  
2004 - present Member, Graduate Affairs Committee, Department of Biology  
2004 - present Member, Committee on Systems Biology Major

## REFEREED PUBLICATIONS

Mangan, EV, Kingsley, DA, Quinn, RD, Sutton, GP, Mansour, JM and Chiel, HJ. (2005) A biologically inspired gripping device. *Industrial Robot* 32:49-54.

Sutton GP, Mangan EV, Neustadter DM, Beer RD, Crago PE, Chiel HJ. (2004) Neural control exploits changing mechanical advantage and context dependence to generate different feeding responses in *Aplysia*. *Biol Cybern.* 91, 333-345.

Sutton GP, Macknin JB, Gartman SS, Sunny GP, Beer RD, Crago PE, Neustadter DM, Chiel HJ. (2004) Passive hinge forces in the feeding apparatus of *Aplysia* aid retraction during biting but not during swallowing. *J Comp Physiol A* 190: 501-514.

Neustadter DM and Chiel HJ. (2004) Imaging freely moving subjects using continuous interleaved orthogonal magnetic resonance imaging, *Magn Reson Imaging* 22, 329 - 343.

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Chestek, C., Samsukha, P., Tabib-Azar, M., Harrison, R., Chiel, H. and Garverick, S. Wireless multi-channel sensor for neurodynamic studies. Third IEEE International Conference on Sensors, Vienna, Austria, October 24 – 27, 2004.

Ovryn, B., Li, X., Chiel, H. and Herlitze, S. (2004) Optical control of a rhodopsin-based switch, in *Three Dimensional and Multidimensional Microscopy: Image Processing and Acquisition XI*, edited by Concello, J-A, Cogswell, C. J. and Wilson, T., Proceedings of SPIE Vol. 5324 (SPIE, Bellingham, WA), pp. 197 – 207.

Mangan, E. V., Kingsley, D. A., Quinn, R. D., Sutton, G. P., Mansour, J. M. and Chiel, H. J. A biologically inspired gripping device. International Conference on Intelligent Manipulation and Grasping (IMG04), Genoa, Italy, July 1, 2004.

Beer, R.D. and Chiel, H.J. 2003. Locomotion, invertebrate. In M. A. Arbib (ed.), *The Handbook of Brain Theory and Neural Networks*, 2nd edition, MIT Press.

Neustadter, D. M., Drushel, R. F., Crago, P. E., Adams, B. W., and Chiel, H. J., 2002, A kinematic model of swallowing in *Aplysia californica* based on radula/odontophore kinematics and *in vivo* MRI, *Journal of Experimental Biology* 205:3177-3206.

Mangan, E. V., Kingsley, D. A., Quinn, R. D. and Chiel, H. J., 2002, Development of a peristaltic endoscope, International Congress on Robotics and Automation 2002, pp. 347-352.

Drushel, R. F., Sutton, G. P., Neustadter, D. M., Mangan, E. V., Adams, B. W., Crago, P. E. and Chiel, H. J., 2002, Radula-centric and odontophore-centric kinematic models of swallowing in *Aplysia*, *Journal of Experimental Biology* 205: 2029-2051.

Neustadter, D. M., Drushel, R. F., and Chiel, H. J., 2002, Kinematics of the buccal mass during swallowing based on magnetic resonance imaging in intact, behaving *Aplysia californica*, *Journal of Experimental Biology* 205:939-958.

Chiel, H. J. and Beer, R. D., 2000, Neural networks and Behavior, in *Embryonic Encyclopedia of Life Sciences*, Nature Publishing Group: London, www.els.net.

Chiel, H. J. and Beer, R.D., 2000, Commentary: Biomechanical studies clarify pattern generator circuits, in *Biomechanics and Neural Control of Movement*, Winters J. M. and Crago, P. E., eds., Springer-Verlag, pp. 218 - 220.

Beer, R. D. and Chiel, H. J., 2000, Commentary: Neural control and biomechanics in the locomotion of insects and robots, *Biomechanics and Neural Control of Movement*, Winters J. M. and Crago, P. E., eds., Springer-Verlag, pp. 240 - 242.

Vaidyanathan, R., Chiel, H. J., and Quinn, R.D., 2000, A hydrostatic robot for marine applications. *Robotics and Autonomous Systems* 30:103 - 113.

Yu, S.-N., Crago, P. E., and Chiel, H. J., 1999, Biomechanical properties and a kinetic simulation model of the smooth muscle I2 in the buccal mass of *Aplysia*. *Biological Cybernetics* 81:505 - 513.

Chiel, H. J., Beer, R. D., and Gallagher, J. C., 1999, Evolution and analysis of model CPGs for walking I. Dynamical modules. *Journal of Computational Neuroscience* 7:99 - 118.

Beer, R. D., Chiel, H. J., and Gallagher, J. C., 1999, Evolution and analysis of model CPGs for walking II. General principles and individual variability. *Journal of Computational Neuroscience* 7:119 - 147.

Beer, R. D., Chiel, H. J., and Drushel, R. F., 1999, Using autonomous robotics to teach science and engineering. *Communications of the Association for Computing Machinery* 42:85 - 92.

Neustadter, D.M., Drushel, R. F., Crago, P. E., and Chiel, H. J., 1998, Modeling the Biomechanics of Molluscan Feeding, *Comments on Theoretical Biology* 5:119-143

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Beer, R. D., Chiel, H. J., Quinn, R. D., and Ritzmann, R. E., 1998, Biorobotic approaches to the study of motor systems, *Current Opinion in Neurobiology* 8:777-782.

Drushel, R. F., Neustadter, D. M., Hurwitz, I., Crago, P. E. and Chiel, H. J., 1998, Kinematic models of the buccal mass of *Aplysia*, *J. Exp. Biol.* 201:1563-1583.

Chiel, H. J. and Beer, R.D., 1997, The Brain has a Body: Adaptive behavior emerges from interactions of nervous system, body, and environment, *Trends in Neurosciences* 20:553 - 557.

Yu, S.-Y., Crago, P. E., and Chiel, H. J., 1997, A non-isometric kinetic model of smooth muscle, *Amer. J. Physiol.* 272: *Cell Physiol.* 41: C1025 - C1039.

Drushel, R. F., Neustadter, D. M., Shallenberger, L.L., Crago, P.E., and Chiel, H.J., 1997, The kinematics of swallowing in the buccal mass of *Aplysia californica*, *J. Exp. Biol.* 200: 735 - 752.

Vaidyanathan, R., Chiel, H.J., and Quinn, R. D., 1997, A hydrostatic robot for marine applications, *Eleventh Symposium on Structural Dynamics and Control*, Virginia Tech.

Beer, R.D., Quinn, R.D., Chiel, H.J., and Ritzmann, R.E., 1997. Biologically-inspired approaches to robotics, *Communications of the Association for Computing Machinery*, 40:30 - 38.

Chiel, H.J., 1996, Critical thinking in a neurobiology course, *Bioscene: Journal of College Biology Teaching* 22:3 - 14.

Hurwitz, I, Neustadter, D., Morton, D. W., Chiel, H. J., and Susswein, A.J., 1996. Activity patterns of the B31/B32 pattern initiators innervating the I2 muscle of the buccal mass during normal feeding movements in *Aplysia californica*, *J. Neurophysiol.* 75:1309-1326.

Espenschied, K. S., Quinn, R. D., Chiel, H. J., and Beer, R. D., 1996, Biologically-based distributed control and local reflexes improve rough terrain locomotion in a hexapod robot, *Robotics and Autonomous Systems*, 18:59 - 64.

Warman, E. N. and Chiel, H.J. 1995. A new technique for chronic single extracellular recording in freely behaving animals using pipette electrodes, *J. Neurosci. Methods*, 57:161-169.

Beer, R.D. and Chiel, H.J. 1995. Locomotion, invertebrate. In M. A. Arbib (ed.), *The Handbook of Brain Theory and Neural Networks*, MIT Press, pp. 553 - 556.

Beer, R.D., Ritzmann, R.E. and Chiel, H.J. 1995. Models of the neural basis of insect behavior. In *An Introduction to Neural and Electronic Networks*, 2nd ed., Zornetzer, S.F., Davis, J.L., Lau, C., and McKenna, T. (eds), Academic Press, San Diego, CA, pp. 165 - 184.

Espenschied, K. S., Quinn, R. D., Chiel, H. J., Beer, R. D., 1994. Biologically-inspired hexapod robot control. In: *Proceedings of the Fifth International Symposium on Robotics and Manufacturing (ISRAM)*.

Morton, D. W. and Chiel, H. J. 1994. Neural architectures for adaptive behavior. *Trends in Neurosciences*, 17:413-420.

Morton, D. W. and Chiel, H. J. 1993. The timing of activity in motor neurons that produce radula movements distinguishes ingestion-like and rejection-like motor patterns in a reduced preparation of *Aplysia*, *J. Comp. Physiol. A.*, 173:519 - 536.

Espenschied, K. S., Quinn, R. D., Chiel, H. J., and Beer, R. D. 1993. Leg coordination mechanisms in stick insect applied to hexapod robot locomotion, *Adaptive Behavior*, 1(4):455 - 468.

Chiel, H. J. and Susswein, A. J. 1993. Learning that food is inedible in freely-behaving *Aplysia californica*, *Behavioral Neuroscience*, 107(2):327-338.

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Morton, D. W. and Chiel, H. J. 1993. *In vivo* buccal nerve activity that distinguishes ingestion from rejection can be used to predict behavioral transitions in *Aplysia*, *J. Comp. Physiol. A.*, 172:17-32.

Srinivasan, R. and Chiel, H. J. 1993. Fast calculation of synaptic conductances. *Neural Computation*, 5(2): 200 - 204.

Chiel, H. J., 1993. Cognitive Neuroethology: An Approach to Understanding Biological Neural Networks, in *Intelligent Systems -- Concepts and Applications*, L. Sterling, ed., Plenum Press, pp. 143 - 167.

Chiel, H. J. and Beer, R. D. 1993. Neural and Peripheral Dynamics as Determinants of Patterned Motor Behavior, in *The Neurobiology of Neural Networks*, D. Gardner, ed., M.I.T. Press, pp. 137 - 164.

Chiel, H. J., Crago, P., Mansour, J. M. and Hathi, K. 1992. Biomechanics of a muscular hydrostat: A model of lapping by a reptilian tongue, *Biological Cybernetics*, 67:403-415.

Beer, R.D. and Chiel, H.J. 1992. Simulations of cockroach locomotion and escape. In *Biological Neural Networks in Invertebrate Neuroethology and Robotics*, Beer, R.D., Ritzmann, R.E. and McKenna, T. (eds), Academic Press, pp. 267 - 285.

Chiel, H. J., Beer, R. D., Quinn, R. D., and Espenschied, K. S. 1992. Robustness of a distributed neural network controller for locomotion in a hexapod robot, *IEEE Transactions on Robotics and Automation*, 8(3):293 - 303. [Reprinted in *Neural Networks for Robotic Control Theory and Applications*, Zalzal, A. M. S. and Morris, A. S., eds., Prentice Hall, 1996]

Beer, R. D., Chiel, H. J., Quinn, R. D., Espenschied, K., and Larsson, P. 1992. A distributed neural network architecture for hexapod robot locomotion, *Neural Computation*, 4:356-365.

Morton, D. W., Chiel, H. J., Cohen, L. B., and Wu, J.-Y., 1991. Optical methods can be utilized to map the location and activity of putative motor neurons and interneurons during rhythmic patterns of activity in the buccal ganglion of *Aplysia*, *Brain Research*, 564:45-55.

Chiel, H. J. and Beer, R. D., 1991. Simulation of Adaptive Behavior. In *Current Opinion in Neurobiology*, *Neural Control*, S. Grillner and M. Konishi, eds., 1 (4): 605 - 609.

Chiel, H.J., Weiss, K.R., and Kupfermann, I., 1991. Histamine as a transmitter in invertebrates: Studies of identified cells in *Aplysia*. In: *Histaminergic Neurons: Morphology and Function*, T. Watanabe and H. Wada (eds.), CRC Press, Boca Raton, Florida, pp. 209-227.

Beer, R. D., Kacmarcik, G. J., Ritzmann, R. E., and Chiel, H. J. 1991. A model of distributed sensorimotor control in the cockroach escape turn. In: *Advances in Neural Information Processing Systems 3*, R. P. Lippmann, J. Moody and D. S. Touretzky (eds.), Morgan Kaufmann Publishers, Palo Alto, CA, pp. 507-513.

Beer, R. D. and Chiel, H. J. , 1991. The neural basis of behavioral choice in an artificial insect. In: *From Animals to Animats: Proceedings of the First International Conference on Simulation of Adaptive Behavior*, J.-A. Meyer and S.W. Wilson (eds.), The MIT Press, Cambridge, Massachusetts, pp.247-254.

Beer, R.D., Chiel, H.J., and Sterling, L.S., 1991. An artificial insect. *American Scientist* 79:444-452.

Sterling, L. S., Beer, R. D. and Chiel, H. J. 1991. Beyond the symbolic paradigm. In: *Future Directions in Artificial Intelligence*, P. A. Flach and R. A. Meersman (eds.), Elsevier Science Publishers B.V., Amsterdam, The Netherlands, pp. 71-79.

Kleinfeld, D., Chiel, H.J., and Sompolinsky, H. 1991. Small nervous systems and neural network models, In *Nonlinear Dynamics and Neuronal Networks*, H.G. Schuster (ed.), Weinheim, NY, VCH.

Chiel, H.J., Weiss, K.R., and Kupfermann, I., 1990. Multiple roles of a histaminergic afferent neuron

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in the feeding behaviour of *Aplysia*. *Trends in Neurosciences* 13:223-227.

Beer, R. D. and Chiel, H. J. , 1990. Neural Implementation of Motivated Behavior: Feeding in an Artificial Insect, In *Advances in Neural Information Processing Systems* 2, D. S. Touretzky (ed.), Morgan Kaufmann Publishers, Palo Alto, CA, pp. 44-51.

Beer, R. D., Chiel, H.J., and Sterling, L. 1990. A Biological Perspective on Autonomous Agent Design, *Robotics and Autonomous Systems* 6: 169-186.

Kleinfeld, D., Raccuia-Behling, G. F., and Chiel, H. J. 1990. Circuits constructed from identified *Aplysia* neurons exhibit multiple patterns of persistent activity. *Biophys. J.* 57:697-715.

Chiel, H. J. and Beer, R. D. 1989. A lesion study of a heterogeneous artificial neural network for hexapod locomotion. *International Joint Conference on Neural Networks*, Vol. 1, IEEE TAB Neural Network Committee, pp. 407-414.

Beer, R. D., Quinn, R. D., Chiel, H. J., Ritzmann, R. and Sterling, L. S. 1989. Distributed neural control of a hexapod walking vehicle, *Proceedings of the Third Annual Conference on Aerospace Computational Control*, Oxnard, CA, pp. 664 - 673.

Beer, R. D., Chiel, H. J., and Sterling, L. 1989. Heterogenous neural networks for adaptive behavior in dynamic environments. *Advances in Neural Information Processing Systems*, Vol.1, D. Touretzky, ed., Morgan Kaufman Publishers, Palo Alto, CA., pp. 577-585.

Chiel, H. J., Weiss, K. R., and Kupfermann, I. 1988. An identified histaminergic neuron acts postsynaptically and presynaptically to modulate outputs of feeding motor programs in *Aplysia*. *J.Neurosci.* 8: 49-63.

Chiel, H. J., Weiss, K. R., and Kupfermann, I., 1986. An identified histaminergic neuron modulates feeding motor circuitry in *Aplysia*. *J. Neurosci.* 6: 2427-2450.

Weiss, K. R., Chiel, H. J., and Kupfermann, I., 1986. Sensory function and gating of histaminergic neuron C2 in *Aplysia*. *J. Neurosci.* 6: 2416-2426.

Weiss, K. R., Chiel, H. J., Koch, U., and Kupfermann, I., 1986. Activity of an identified histaminergic neuron, and its possible role in arousal of feeding behavior in semi-intact *Aplysia*. *J. Neurosci.* 6: 2403-2415.

Chiel, H. J., and Wurtman, R. J., 1981. Short-term variations in diet composition change the pattern of spontaneous motor activity in rats. *Science* 213: 676-678.

Sahakian, B. J., Wurtman, R. J., Barr, J. K., Millington, W. R., and Chiel, H. J., 1979. Low tryptophan diet decreases brain serotonin and alters response to apomorphine. *Nature* 279: 731-732.

Moskowitz, M. A., Chiel, H. J., and Lytle, L., 1979. Neurotransmitters: alterations with aging and precursor availability. In: *Current Neurology*, Vol. 2, Tyler, H. R. and Dawson, D. M. (eds.). Houghton-Mifflin: Boston, 377-388.

Moskowitz, M. A., Chiel, H. J., and Lytle, L., 1978. Neurotransmitters and diseases of the nervous system. In: *Current Neurology*, Vol. 1, Tyler, H. R. and Dawson, D. M. (eds.). Houghton-Mifflin: Boston, 390-436.

Chiel, H. J. and Wurtman, R. J., 1976. Suppression of amphetamine-induced hypothermia by the neutral amino acid valine. *Psychopharm. Commun* 2: 207-217.

Chiel, H. J., Yehuda, S., and Wurtman, R. J., 1974. Development of tolerance in rats to the hypothermic effects of d-amphetamine and apomorphine. *Life Sci.* 14: 483-488.

## Abstracts

Hillel J. Chiel, Ph.D.

Chestek, C. A., Garverick, S. L., Tabib-Azar, M., Harrison, R.R., Martin, H.B., Lu, H., Samsukha, P. and Chiel, H.J. Techniques for stimulating and recording wirelessly from a multiaction identified neuron in *Aplysia*. Program No. 537.7. 2004. Abstract Viewer/Itinerary Planner. Washington, DC: Society for Neuroscience.

Magnan, E.V., Kingsley, D. A., Quinn, R.D., Sutton, G. P., Mansour, J.M., and Chiel, H.J. Biologically inspired soft robotics. Program No. 537.8. 2004 Abstract Viewer/Itinerary Planner. Washington, DC: Society for Neuroscience.

Xie, S., Blankenship, B.D., Halpern, J. M., Chestek, C. A., Lu, H., Chiel, H. and Martin, H. B. Boron-Doped Diamond Neurosensors and Neural Stimulating Electrodes, Ninth International Symposium on Diamond Materials, Meeting of the Electrochemical Society, Honolulu, HI, Oct. 7, 2004.

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### **Invited Presentations**

2/2/84 - Department of Zoology, University College London, London, UK, "Modulation of Complex

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- Behavior".
- 4/15/85 - Department of Biology, University of Pennsylvania, Philadelphia, PA, "Modulation of Feeding Behavior in a Simple Invertebrate, *Aplysia*"
- 3/10/86 - Department of Molecular Biophysics Research, AT&T Bell Laboratories, Murray Hill, NJ, "Neural Basis of Complex Behavior in *Aplysia*".
- 10/27/86 - Department of Neurobiology, Harvard Medical School, Boston, MA, "Presynaptic inhibition and the coordination of feeding behavior in *Aplysia*".
- 1/22/87 - Department of Biology, CWRU, Cleveland, OH, "Presynaptic inhibition and the coordination of feeding behavior in *Aplysia*".
- 1/28/87 - Department of Neurosurgery, Tufts University Medical School, Boston, MA, "Presynaptic inhibition and the coordination of feeding behavior in *Aplysia*".
- 3/4/87 - Department of Anatomy and Cell Biology, State University of New York, Health Science Center at Brooklyn, Brooklyn, NY, "Presynaptic inhibition and the coordination of feeding behavior in *Aplysia*".
- 10/20/87 - Invited paper for Proceedings of IEEE Systems Man and Cybernetics, Alexandria, VA, "Associative Neural Networks and Central Pattern Generators: An Experimental Perspective."
- 2/24/88 - Center for Neurosciences, Medical School, CWRU, Cleveland, OH, "Feeding in *Aplysia*: A model system for the study of complex behavior"
- 3/28/88 - Department of Physics, CWRU, Cleveland, OH, "Biological and theoretical neural networks: is there a connection?"
- 10/2/88 - Invited Platform talk, Cell and Molecular Neurobiology of *Aplysia*, Cold Spring Harbor, NY, "Analysis of presynaptic inhibition using *Aplysia* neurons in culture"
- 10/11/88 - Department of Pharmacology, Medical School, CWRU, Cleveland, OH, "Role of a histaminergic neuron in the feeding behavior of *Aplysia*"
- 4/5/89 - Cleveland Neuropsychological Association, Cleveland, OH, "Neural Networks for Adaptive Behavior"
- 5/10/89 - Annual Sigma Xi Lecture, CWRU Chapter, Cleveland, OH, "Neural Networks for Adaptive Behavior"
- 6/20/89 - International Joint Conference on Neural Networks, Washington, D.C., "A lesion study of a heterogeneous artificial neural network for hexapod locomotion"
- 11/16/89 - Department of Pulmonary Medicine, CWRU, Cleveland, OH, "Cellular basis of feeding in *Aplysia*"
- 1/24/90 - The Neural Computation Project, The Salk Institute, San Diego, CA, "Biologically based neural networks for autonomous behavior in an artificial insect"
- 1/25/90 - Computation and Neural Systems Department, California Institute of Technology, Pasadena, CA, "Experimental and simulation studies of invertebrate neural networks", and "Biologically based neural networks for autonomous behavior in an artificial insect"
- 5/17/90 - National Science Foundation Workshop, Bio-Control by Neural Networks, Washington, D.C., "Control of Locomotion in a Simulated Insect Using Heterogeneous Neural Nets".
- 9/26/91 - Department of Biology, CWRU, Cleveland, OH, "*Aplysia* feeding as a model system for the study of adaptive behavior".
- 11/3/91 - Office of Naval Research Workshop, Novel Robotic Actuators, Washington, D.C., "Adaptive neural control and biomechanics of a muscular grasper: The feeding apparatus of *Aplysia*."
- 3/31/92 - Jacques Monod Conference, Locomotion: from neural networks to Cognition, Aussois, France, "Simulation of adaptive behavior in a hexapod".
- 9/21/92 - Department of Psychology, CWRU, Cleveland, OH, "Analysis and Synthesis of Adaptive Behavior in Simpler Animals".
- 10/1/92 - Howard Hughes Medical Institute, 1992 Undergraduate Program Directors Meeting, Bethesda, M.D., "Interdisciplinary Programs for Undergraduates".
- 10/21/92 - Department of Mathematics, CWRU, Cleveland, OH, "Dynamics of Adaptive Behavior".
- 1/11/93 - MetroHealth Medical Center, Cleveland, OH, Basic Science for the Clinician VI, "Principles of Neurobiology".
- 5/20/93 - Case School of Engineering, Intelligent Systems - Concepts and Applications: A Symposium in Honor of Professor Yoh-Han Pao, CWRU, Cleveland, OH, "Cognitive Neuroethology: An Approach to Understanding Biological Neural Networks".
- 6/20/93 - Department of Biology, Hebrew University, Jerusalem, Israel, "Analysis and Synthesis of Adaptive Behavior in Simpler Animals".
- 7/21/93 - Santa Fe Institute Workshop, Dynamic Control of Stability and Flexibility in the Nervous System (organizer: Dr. Nancy Kopell), Santa Fe, New Mexico, "Dynamics of Adaptive

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- Behavior".
- 10/19/93 - Department of Biological Sciences, University of Illinois at Chicago, Chicago, Illinois, "Analysis and Synthesis of Adaptive Behavior".
- 1/12/94 - Department of Cellular and Molecular Physiology, Yale University School of Medicine, New Haven, Connecticut, "Neural Networks for Adaptive Behavior".
- 2/2/94 - Department of Neuroscience, Case Western Reserve University School of Medicine, Cleveland, OH, "Neural Networks for Adaptive Behavior".
- 2/7/94 - Department of Biology, Georgia State University, Atlanta, GA, "Neural Networks for Adaptive Behavior".
- 4/28/94 - National Science Foundation Workshop, Establishing databases of identified neurons (Gwen Jacobs and Chris Comer, organizers), Arlington, VA, Discussion leader, "Database formats; solutions for different organisms".
- 10/4/94 - Howard Hughes Medical Institute, 1994 Program Directors Meeting, Undergraduate Biological Sciences Education Program, Chevy Chase, MD, "Demonstrations of Educational Technology".
- 12/8/94 - Neuroscience Group, Oberlin College, Oberlin, OH, "The Neural Basis of Adaptive Behavior in the Marine Mollusc *Aplysia*".
- 1/26/95 - M.I.T. Club of Northeast Ohio, Cleveland, OH, "Simpler Animals and Smarter Robots".
- 6/2/95 - Krasnow Institute for Advanced Study, Workshop on Evolution, Neurobiology and Behavior, Fairfax, VA, "Neural Architectures for Adaptive Behavior".
- 6/22/95 - Department of Medical Physiology, University of Calgary Medical School, Calgary, Canada, "Neural Mechanisms of Adaptive Behavior".
- 10/27/95 - Howard Hughes Medical Institute, 1995 Program Directors Meeting, Undergraduate Biological Sciences Education Program, Chevy Chase, MD, Moderator of Workshop "Educational Technology - Off-the-Shelf or Build-it-Yourself?".
- 1/12/96 - Santa Fe Institute Colloquium Series, Santa Fe, New Mexico, "Coupling of Central and Peripheral Dynamics in Adaptive Behavior".
- 5/13/96 - Santa Fe Institute, Santa Fe, New Mexico, Workshop on Dynamics, Computation and Cognition, "Cognitive Neuroethology: a neurobiological approach to the study of cognition".
- 8/30/96 - Guest lecture, English 200, CWRU, "Literature, Language, and the Brain".
- 10/28/96 - Autonomous Agents Group, Artificial Intelligence Laboratory, MIT, Cambridge, Ma, "Neural Architecture and Biomechanics in the Generation of Adaptive Behavior".
- 10/29/96 - Volen Center for Complex Systems, Brandeis University, Waltham, MA, "Mechanisms of Adaptive Behavior: Experimental and Theoretical Studies".
- 5/29/97 - M.I.T., Cambridge, MA, "Biomechanics and Control of Muscular Hydrostatic Structures", Legged Locomotion Workshop.
- 9/9/97 - Invited speaker at Symposium, Network Modeling, 5th International Conference on Invertebrate Neurochemistry and Neurophysiology, Eilat, Israel, "Neural Networks for Adaptive Behavior and Robotics".
- 11/12/97 - Department of Neuroscience, Case Western Reserve University School of Medicine, Cleveland, OH, "Biomechanics and Neural Control of Feeding in *Aplysia*".
- 4/23/98 - Department of Biology, Case Western Reserve University, Cleveland, OH, "Neural and Biomechanical Mechanisms of Adaptive Behavior".
- 8/25/98 - Invited speaker at Symposium, Modeling neural systems, 5th International Congress of Neuroethology, San Diego, California, "Biomechanics and neural control of the feeding apparatus of *Aplysia californica*".
- 1/29/99 - Neuromechanics Group, Case Western Reserve University, Cleveland, OH, "Biomechanics and Neural Control of Muscular Hydrostatic Structures"
- 3/9/99 - Neuroscience Program Seminar Series, Beckman Institute, University of Illinois at Urbana-Champaign, Urbana, Illinois, "Biomechanical and Neural Mechanisms of Adaptive Behavior".
- 5/2/99 - Participant in Learning and Intelligent Systems Principal Investigators Conference sponsored by the National Science Foundation, Georgetown University Conference Center, Washington, D.C.
- 11/16/1999 - "Neural and Biomechanical Mechanisms of Adaptive Behavior", Department of Biomedical Engineering, Case Western Reserve University, Cleveland, OH 44106.
- 6/13/2000 - "Neural and Biomechanical Mechanisms of Adaptive Behavior", MRI Systems Group, GE Medical Systems Magnetic Resonance, Haifa, Israel.
- 1/16/2001 - "Towards a Theory of Pattern Generation", Workshop on Computational and Mathematical Problems Arising from Neurophysiology, The Rothschild Institute of Computer Science, Haifa University, Haifa, Israel.

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- 6/1/2001 - "Neuromechanical Modeling and Experimental Analysis of Feeding Behavior in *Aplysia*", Stockholm Workshop on Computational Neuroscience, Rimbo, Sweden.
- 7/11/2001 - "Dynamics of Biological Systems", Nord Lecture Series, Case Western Reserve University, Cleveland, OH.
- 8/7/2001 - "Neural and Mechanical Mechanisms of Adaptive Behavior", MRI Systems Group, GE Medical Systems Magnetic Resonance, Haifa, Israel.
- 11/28/2001 - "Neuromechanical Modeling and Experimental Analysis of Feeding Behavior in *Aplysia*", Medical Science Training Program, CWRU, Cleveland, OH.
- 12/18/2001 - "Towards a Theory of Pattern Generation", MRI Systems Group, GE Medical Systems Magnetic Resonance, Haifa, Israel.
- 5/30/2002 - "Biomechanics and Neural Control of Adaptive Behavior", Department of Physiology and Biophysics, Mt. Sinai Medical Center, New York, NY.
- 10/07/2002 - "Biomechanics and Neural Control of Adaptive Behavior", Department of Pathology, CWRU School of Medicine, Cleveland, OH.
- 09/15/2003 - "Neuromechanical Mechanisms of Adaptive Behavior", The Neuroscience Interest Group, CWRU School of Medicine, Cleveland, OH.
- 10/21/2003 - "What is an Invention, Who is an Inventor", Technology Transfer Invention Forum, CWRU, Cleveland, OH.
- 12/01/2003 - "Neuromechanics of Multifunctionality", Center for BioDynamics, Department of Mathematics, Boston University, Boston, MA.
- 12/04/2003 - "Neuromechanics of Multifunctionality", Concord Field Station, Department of Organismic and Evolutionary Biology, Harvard University, Bedford, MA.
- 11/11/2004 Wittke Lecture, Case Western Reserve University, Cleveland, OH.
- 12/02/2004 "Neural and Biomechanical Mechanisms of Multifunctionality in *Aplysia californica*", Department of Biology, CWRU, Cleveland, OH.
- 03/08/2005 "Neural and Biomechanical Mechanisms of Multifunctionality in *Aplysia*: Why a Hand and a Brain are Sometimes Better than a Swiss Army Knife", Department of Neurosciences, Oberlin College, Oberlin, OH.
- 03/08/2005 "Dynamics of Adaptive Behavior: Theory and Practice", Department of Mathematics, Oberlin College, Oberlin, OH.