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<td>Dr. Terrence J. Sejnowski</td>
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<td>Department of the Navy Office of The Chief of Naval Research 800 North Quincy Street Arlington, VA 22217-5660</td>
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<td>The Woods Hole Workshop on Computational Neuroscience at the Marine Biological Laboratory was held for one week each August in 1992 to 1994. Each year, twenty investigators who are concerned with the computational functions of nervous systems had intense discussion on a wide range of topics in computational neuroscience, including neural mechanisms for computation, neural systems for long-term memory, neural decisions, and active perception. In addition, some members of the workshop lectured in the concurrent Computational Neuroscience Course at MBL, and students were invited to attend the workshop.</td>
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Standard Form 298 (Rev. 2-89) Prescribed by ANSI Std. Z39-18 298-102
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| Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88). |
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| PE - Program   | WU - Work Unit       |
| Element        | Accession No.        |

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| Block 13. Abstract. Include a brief (Maximum 200 words) factual summary of the most significant information contained in the report. |

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Summary

The Woods Hole Workshop on Computational Neuroscience at the Marine Biological Laboratory was held for one week each August in 1992 to 1994. Each year, twenty investigators who are concerned with the computational functions of nervous systems had intense discussion on a wide range of topics in computational neuroscience, including neural mechanisms for computation, neural systems for long-term memory, neural decisions, and active perception. In addition, some members of the workshop lectured in the concurrent Computational Neuroscience Course at MBL, and students were invited to attend the workshop.

Organization of the Workshop:

The Woods Hole Workshop on Computational Neuroscience at the Marine Biological Laboratory (MBL) was first held in 1984. Organized by Terrence Sejnowski, it brought together, for the first time, leading researchers from neuroscience and computer science who were concerned with understanding the computational resources of nervous systems. Since 1987, the workshop has been held in conjunction with the Summer Course on Computational Neuroscience at the Marine Biological Laboratory. The week-long workshop has been held during the last week of the month-long summer course, and members of the workshop serve as faculty for the students.

Each participant was allowed 90 minutes to present a new finding, including discussion. Two general sessions were held each day, one in the morning from 9 AM to 12 Noon, and the second in the evening from 7 PM to 10 PM. Each session included two presentations, one from an experimentalist, and one from a theoretician. The afternoons were free to allow the participants to form small groups for lunch and other activities. These activities included interactions with the students in the summer course; a picnic organized by Robert Bosler, a resident of Woods Hole, and a student-faculty volleyball game. The special environment in Woods Hole, which is a major summer research center in neurobiology and has
great physical beauty, has given the workshops a perfect setting and created an ideal place for cross disciplinary interactions to occur.

The central themes of the three workshops that were held at the Marine Biological Laboratory from 1992 to 1994 were neural coding and dynamical information processing in large populations of neurons. A majority of the participants in these workshops were experts on visual processing, but selected sessions on auditory and olfactory coding were also highlighted. In the three years summarized here, a total of 60 researchers participated in the workshops (see appendix).

Neural mechanisms for computation. Each workshop included several talks that were concerned with the biophysical mechanisms that are responsible for information processing in neurons. For example, in 1994, two sessions were devoted to the information carried by single spikes (Sejnowski: spike initiation; Koch: spike timing in area MT; Bialek: adaptive temporal filtering in the fly motion processing system). The issue of temporal processing of information was also address in talk by Laurent, on the olfactory coding in the locust, and by Seung on the neural integrator in the oculomotor system.

Neural systems for long-term memory An important issue that arose in the 1994 workshop was the coding of space in the hippocampus (Wilson) and the learning mechanisms that might be responsible for forming new spatial representations (Abbott and Lisman). In addition, a modeling talk that explored the dynamics of attractor networks was presented that might account for new observations regarding the tendency for hippocampal neurons to form spatial clusters (Tsodyks). Tishby also presented an analysis of data from the visual cortex that indicated a similar tendency of cortical neurons to form temporal clusters during a delayed match-to-sample task.

Neural decisions. Over the last several years, recordings of single neurons from area MT have revealed that single neurons are capable of encoding sensory information with the same accuracy as the response of the monkey. In the best-studied perceptual task, the monkey is asked to decide on the direction of motion in a display of correlated randomly moving dots.. Shadlen showed, in recordings from the parietal region of the monkey cortex, that some neurons reliably encode the decision of the monkey. Maunsell and evidence Desimone also found evidence for decision-related signals in other parts of the monkey’s cortex during tasks that require short-term memory.

Active Perception. Animals are not passive observers, but actively interact with their environment. This is most clearly seen in observer self-motion (Royden) where visual cues in the motion flow field are used
to judge heading. Ballard has pioneered the theoretical study of active perception. At the workshop, he showed that humans favor strategies that rely on eye-movements rather than memory when given free choice in solving a copying task. This suggests that rather than create a detailed internal model of the outside visual world, the visual system instead creates simpler representations that fulfill immediate needs of the motor system when solving a task. Ballard also demonstrated the possibility of studying the performance of humans in complex tasks such driving suing recent advances in virtual reality.

Facilities at MBL

The Workshop was held at MBL because it has the highest concentration of neurobiologists during the summer of any institution in the world, and MBL offers the most advanced training in other aspects of neurobiology during the summer (Courses in Neurobiology, Neural Systems and Behavior, Cellular Neurobiology of the Leech, and Methods in Computational Neuroscience. The overall site is superb from the point of view of facilities (a 24 hour world-class library), location (90 minute drive from Boston), and amenities (restaurants, recreational facilities, computer access all within walking distance).
10th Annual Woods Hole Workshop on Computational Neuroscience

Marine Biological Laboratory
August 22 - August 28, 1994

Monday, August 22

Hippocampal Dynamics

7:00 p.m. Matthew Wilson, University of Arizona
8:30 p.m. Break
9:00 p.m. Laurence Abbott, Brandeis University
10:30 p.m. Beer and wine

Tuesday, August 23

Cortical Dynamics

9:00 a.m. Mishail Tsodyks, Salk Institute
10:30 a.m. Break
11:00 a.m. Rodney Douglas, Oxford
12:30 p.m. Lunch

Neural Assemblies

7:00 p.m. Gilles Laurent, Caltech
8:30 p.m. Break
9:00 p.m. Naftali Tishby, Hebrew University
10:30 p.m. Beer and wine

Wednesday, August 24

Visual Attending

9:00 a.m. Alexander Pentland, MIT Media Laboratoty
10:30 a.m. Break
11:00 a.m. Robert Desimone, NIMH
12:30 p.m. Lunch

Cortical Mechanisms

7:00 p.m. David Kleinfeld, AT&T Bell Laboratories
8:30 p.m. Break
9:00 p.m. David Tank, AT&T Bell Laboratories
10:30 p.m. Beer and wine
Thursday, August 25  

Cortical Processing

9:00 a.m.  Steven Zucker, McGill University
10:30 a.m.  Break
11:00 a.m.  Allan Dobbins, Caltech
12:30 p.m.  Lunch

Active Vision

7:00 p.m.  Constance Royden, Wellesley College
8:30 p.m.  Break
9:00 p.m.  Dana Ballard, Rochester University
10:30 p.m.  Beer and Wine

Friday, August 26  

Visual Decisions

9:00 a.m.  John Maunsell, Baylor College of Medicine
10:30 a.m.  Break
11:00 a.m.  Michael Shadlen, Stanford University
12:30 p.m.  Lunch

Neuronal Reliability

7:00 p.m.  Christof Koch, Caltech
8:30 p.m.  Break
9:00 p.m.  Terrence Sejnowski, Salk Institute
10:30 p.m.  Beer and wine

Saturday, August 27  

Sensory Statistics

9:00 a.m.  Fabrizio Gabbiani, Caltech
10:30 a.m.  Break
11:00 a.m.  William Bialek, NEC Research
12:30 p.m.  Lunch

3:00 p.m.  Student Demonstrations
6:00 p.m.  Lobster Banquet
Woods Hole Workshop on Computational Neuroscience - 1994
Marine Biological Laboratory

Participants

Dr. John Allman
Division of Biology 216-76
Caltech
Pasadena, CA 91125

Dr. Rodney Douglas
MRC Anatomical Neuropharmacology Unit
Mansfield Road
Oxford, OX1 3TH, ENGLAND

Dr. Laurence Abbott
Physics Department
Brandies University
South Street
Waltham, MA 02254

Dr. Fabrizio Gabbiani
Division of Biology 216-76
Caltech
Pasadena, CA 91125

Dr. Dana Ballard
Department of Computer Science
University of Rochester
Rochester, NY 14627

Dr. David Kleinfeld
AT&T Bell Laboratories
Room 6H 424
600 Mountain Avenue
Murray Hill, NJ 07974

Dr. William Bialek
NEC Research Institute
4 Independence Way
Princeton, NJ 08540

Dr. Christof Koch
Division of Biology 216-76
Caltech
Pasadena, CA 91125

Dr. Linda Buck
Department of Neurobiology
Harvard Medical School
25 Shattuck Street
Boston, MA 02115

Dr. Gilles Laurent
Division of Biology 216-76
Caltech
Pasadena, CA 91125

Dr. Joel Davis
Department of the Navy
Office of Naval Research
Arlington, VA 22217-5000

Dr. John Maunsell
Division of Neuroscience
Baylor College of Medicine
1 Baylor Plaza, S603
Houston, TX 77030

Dr. Robert Desimone
Lab Neuropsychology
NIMH - Bldg. 9, Rm. 1N107
Bethesda, MD 20892

Dr. Thomas McKenna
Department of the Navy
Office of Naval Research
Arlington, VA 22217-5000

Dr. Allan Dobbins
Division of Biology 216-76
Caltech
Pasadena, CA 91125

Dr. Alexander Pentland
Media Laboratory
MIT
Cambridge, MA 02139
August 8, 1995

Scientific Officer Code: 1142BI
Joel L. Davis
Office of Naval Research
800 North Quincy Street
Arlington VA 22217-5000

Subj: Final Report

Ref: ONR Grant N00014-92-J-1442

Gentlemen:

On behalf of the Marine Biological Laboratory and the Principal Investigator of the above-referenced grant, Dr. Terrence Sejnowski, I enclose three copies of the final report for the "Workshop in Computational Neuroscience".

Please contact this office if you have any questions or require additional information.

Sincerely,

Sharon L. Hunt
Grants Assistant

Enclosures

Copy to: ONR Grant Administrator (1 copy)
        DTIC (1 copy)
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<td>Computational Neurobiology Lab</td>
<td>The Salk Institute</td>
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<tr>
<td></td>
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<td>P. O. Box 85800</td>
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<td>Montreal, Quebec H3A 2</td>
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<tr>
<td>Dr. Stanzi Royden</td>
<td>Computer Science Dept.</td>
<td>Wellesley College</td>
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<tr>
<td>Dr. Michael Shadlen</td>
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<td>Stanford Medical School</td>
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<td>Dr. Naftali Tishby</td>
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<td>Center for Neural Computation</td>
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<td>Dr. Matthew Wilson</td>
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9th Annual Woods Hole Workshop on
Computational Neuroscience

Marine Biological Laboratory
August 21 - August 27, 1993

Saturday, August 21

Reception
7:00 p.m.  Beer and wine

Sunday, August 22

Sensory Coding
9:00 a.m.  Linda Buck, Harvard School of Medicine
10:30 a.m.  Break
11:00 a.m.  William Bialek, NEC
12:30 p.m.  Lunch

Neural Assemblies
7:00 p.m.  Matthew Wilson, University of Arizona
8:30 p.m.  Break
9:00 p.m.  John Allman, Caltech
10:30 p.m.  Beer and wine

Monday, August 23

Visual Representations
9:00 a.m.  Michael Stryker, UC San Francisco
10:30 a.m.  Break
11:00 a.m.  Steven Zucker, McGill University
12:30 p.m.  Lunch

Memory Representations
7:00 p.m.  Robert Desimone, NIH
8:30 p.m.  Break
9:00 p.m.  Dana Ballard, Rochester University
10:30 p.m.  Beer and wine
Tuesday, August 24

Cortical Microcircuits

9:00 a.m. Rodney Douglas, Oxford University
10:30 a.m. Break
11:00 a.m. Douglas Miller, McGill University
12:30 p.m. Lunch

Dendritic Processing

7:00 p.m. David Tank, AT&T Bell Laboratories
8:30 p.m. Break
9:00 p.m. Christof Koch, Caltech
10:30 p.m. Beer and Wine

Wednesday, August 25

Motion Processing

9:00 a.m. Udi Zohary, Stanford Medical School
10:30 a.m. Break
11:00 a.m. Robert de Ruyter, NEC
12:30 p.m. Lunch

Cortical Coding

7:00 p.m. Pieter Roelfsema, Max-Planck, Frankfurt
8:30 p.m. Break
9:00 p.m. David Kleinfeld, AT&T Bell Laboratories
10:30 p.m. Beer and wine

Thursday, August 26

Spatial Representations

9:00 a.m. Apostolos Georgopoulos, University of Minnesota
10:30 a.m. Break
11:00 a.m. Richard Andersen, MIT/Caltech
12:30 p.m. Lunch

Task-Dependent Processing

2:00 p.m. John Maunsell, Baylor School of Medicine
3:30 p.m. Break
4:00 p.m. Terrence Sejnowski, Salk Institute/Caltech
5:30 p.m. Dinner
# Woods Hole Workshop on Computational Neuroscience - 1993
Marine Biological Laboratory

## Participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution/Department</th>
<th>Address</th>
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<tbody>
<tr>
<td>Dr. John Allman</td>
<td>Division of Biology 216-76</td>
<td>Caltech, Pasadena, CA 91125</td>
</tr>
<tr>
<td>Dr. Richard Andersen</td>
<td>Department of Brain and Cognitive Science</td>
<td>MIT, Cambridge, MA 02139</td>
</tr>
<tr>
<td>Dr. Dana Ballard</td>
<td>Department of Computer Science</td>
<td>University of Rochester, Rochester, NY 14627</td>
</tr>
<tr>
<td>Dr. William Bialek</td>
<td>NEC Research Institute</td>
<td>Princeton, NJ 08540</td>
</tr>
<tr>
<td>Dr. Linda Buck</td>
<td>Department of Neurobiology</td>
<td>Harvard Medical School, Boston, MA 02115</td>
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<td>NEC Research Institute</td>
<td>Princeton, NJ 08540</td>
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<td>Department of the Navy</td>
<td>Office of Naval Research, Arlington, VA 22217-5000</td>
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<td>Dr. Robert Desimone</td>
<td>Lab Neuropsychology</td>
<td>NIMH - Bldg. 9, Rm. 1N107, Bethesda, MD 20892</td>
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<tr>
<td>Dr. Rodney Douglas</td>
<td>MRC Anatomical Neuropharmacology Unit</td>
<td>Mansfield Road, Oxford, OX1 3TH, ENGLAND</td>
</tr>
<tr>
<td>Dr. Apostolos Georgopoulos</td>
<td>Brain Science Center</td>
<td>VA Medical Center, One Veterans Drive, Minneapolis, MN 55417</td>
</tr>
<tr>
<td>Dr. David Kleinfeld</td>
<td>AT&amp;T Bell Laboratories</td>
<td>Room 6H 424, 600 Mountain Avenue, Murray Hill, NJ 07974</td>
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<td>Division of Biology 216-76</td>
<td>Caltech, Pasadena, CA 91125</td>
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<tr>
<td>Dr. John Maunsell</td>
<td>Division of Neuroscience</td>
<td>Baylor College of Medicine, 1 Baylor Plaza, S603, Houston, TX 77030</td>
</tr>
<tr>
<td>Dr. Michale Fee</td>
<td>AT&amp;T Bell Laboratories</td>
<td>Room 6H 424, 600 Mountain Avenue, Murray Hill, NJ 07974</td>
</tr>
</tbody>
</table>
Participants

Dr. Douglas Miller
Department of Electrical Engineering
McGill University
3480 University Street
Montreal, Quebec H3A 2

Dr. Thomas McKenna
Department of the Navy Office of Naval Research
Arlington, VA 22217-5000

Dr. Pieter Roelfsema
Max Planck Institute for Brain Research
Postfach 71 06 62
Deutschordenstrasse 46
D-6000 Frankfurt, GERMANY

Dr. Terrence J. Sejnowski
Computational Neurobiology Lab
The Salk Institute
P. O. Box 85800
San Diego, CA 92186

Dr. Michael Stryker
Department of Physiology
University of California School Of Medicine
San Francisco, CA 94143-0444

Dr. David Tank
AT&T Bell Laboratories
Room 1C 427
600 Mountain Avenue
Murray Hill, NJ 07974

Dr. Matthew Wilson
Life Sciences Building
University of Arizona
Tucson, AZ 85724

Dr. Udi Zohary
Department of Neurobiology
Stanford Medical School
Stanford, CA 94395

Dr. Steven Zucker
Department of Electrical Engineering
McGill University
3480 University Street
Montreal, Quebec H3A 2
8th Annual Woods Hole Workshop on Computational Neuroscience

Marine Biological Laboratory
August 22 - August 28, 1992

Saturday, August 22
8:30 p.m. Reception, Loeb 201

Sunday, August 23

Dynamic and Modular Vision

9:00 a.m. Dan Ts'o, Rockefeller University
10:30 a.m. Break
11:00 a.m. Alexander Pentland, MIT Media Lab
12:30 p.m. Lunch

Olfactory Coding

7:00 p.m. John Kauer, Tufts University Medical School
8:30 p.m. Break
9:00 p.m. James Bower, Caltech
10:30 p.m. Beer and wine

Monday, August 24

Olfactory Associations

9:00 a.m. Lewis Haberly, University of Wisconsin
10:30 a.m. Break
11:00 a.m. Michael Hasselmo, Harvard
12:30 p.m. Lunch

Beyond Single Units

7:00 p.m. John Allman, Caltech
8:30 p.m. Break
9:00 p.m. David Tank, AT&T Bell Laboratories
10:30 p.m. Beer and wine
Tuesday, August 25

**Eye Movements**

<table>
<thead>
<tr>
<th>Time</th>
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<tr>
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<td>Carol Colby, NIMH</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Break</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>Dana Ballard, University of Rochester</td>
</tr>
<tr>
<td>12:30 p.m.</td>
<td>Lunch</td>
</tr>
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</table>

**Space and Time**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 p.m.</td>
<td>Richard Andersen, MIT</td>
</tr>
<tr>
<td>8:30 p.m.</td>
<td>Break</td>
</tr>
<tr>
<td>9:00 p.m.</td>
<td>David Kleinfeld, AT&amp;T Bell Laboratories</td>
</tr>
<tr>
<td>10:30 p.m.</td>
<td>Beer and Wine</td>
</tr>
</tbody>
</table>

Wednesday, August 26

**Cortical Circuitry**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
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<tbody>
<tr>
<td>9:00 a.m.</td>
<td>Rodney Douglas, MRC Neuroanatomical Unit, Oxford</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Break</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>A. B. Bonds, Vanderbilt University</td>
</tr>
<tr>
<td>12:30 p.m.</td>
<td>Lunch</td>
</tr>
</tbody>
</table>

**Cortical Development**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
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</thead>
<tbody>
<tr>
<td>7:00 p.m.</td>
<td>Michael Stryker, UC San Francisco</td>
</tr>
<tr>
<td>8:30 p.m.</td>
<td>Break</td>
</tr>
<tr>
<td>9:00 p.m.</td>
<td>Terrence Sejnowski, Salk Institute/UC San Diego</td>
</tr>
<tr>
<td>10:30 p.m.</td>
<td>Beer and wine</td>
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</table>

Thursday, August 27

**Cortical Architecture**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
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</thead>
<tbody>
<tr>
<td>9:00 a.m.</td>
<td>Gary Blasdel, Harvard</td>
</tr>
<tr>
<td>10:30 a.m.</td>
<td>Break</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>Steven Zucker, McGill University</td>
</tr>
<tr>
<td>12:30 p.m.</td>
<td>Lunch</td>
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</table>

**Cortical Coding**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 p.m.</td>
<td>Michael Shadlin, Stanford Medical School</td>
</tr>
<tr>
<td>8:30 p.m.</td>
<td>Break</td>
</tr>
<tr>
<td>9:00 p.m.</td>
<td>Christof Koch, Caltech</td>
</tr>
<tr>
<td>10:30 p.m.</td>
<td>Beer and wine</td>
</tr>
</tbody>
</table>
Woods Hole Workshop on
Computational Neuroscience - 1992
Marine Biological Laboratory

Participants

Dr. John Allman
Division of Biology 216-76
Caltech
Pasadena, CA 91125

Dr. Joel Davis
Department of the Navy
Office of Naval Research
Arlington, VA 22217-5000

Dr. Richard Andersen
Department of Brain
and Cognitive Science
MIT
Cambridge, MA 02139

Dr. Rodney Douglas
MRC Anatomical
Neuropsychology Unit
Mansfield Road
Oxford, OX1 3TH
England

Dr. Dana Ballard
Department of Computer Science
University of Rochester
Rochester, NY 14627

Dr. Lewis Haberly
Department of Anatomy
University of Wisconsin
1255 Linden Dr.
Madison, WI 53706

Dr. Gary Blasdel
Department of Neurobiology
Harvard Medical School
25 Shattuck Street
Boston, MA 02115

Dr. Michael Hasselmo
Department of Psychology
William James Hall
Harvard University
33 Kirkland Street
Cambridge, MA 02138

Dr. A. B. Bonds
Department of Electrical Engineering
Vanderbilt University
Nashville, TN 37235

Dr. John Kauer
Department of Neurosurgery
Tufts University Medical School
NE Medical Center
750 Washington Street
Boston, MA 02111

Dr. James Bower
Division of Biology 216-76
Caltech
Pasadena, CA 91125

Dr. David Kleinfeld
AT&T Bell Laboratories
Room 6H 424
600 Mountain Avenue
Murray Hill, NJ 07974

Dr. Peter Brotchie
Department of Brain
and Cognitive Science
MIT
Cambridge, MA 02139

Dr. Christof Koch
Division of Biology 216-76
Caltech
Pasadena, CA 91125

Dr. Carol Colby
Lab Sensorimotor Res.
NIMH - Bldg. 10, Rm. 10C101
Bethesda, MD 20892
Mr. Mark O'Dell  
Division of Biology 216-76  
Caltech  
Pasadena, CA 91125

Dr. Alexander Pentland  
Media Laboratory  
MIT  
Cambridge, MA 02139

Dr. Ning Qian  
Department of Brain  
and Cognitive Science  
MIT  
Cambridge, MA 02139

Dr. Terrence J. Sejnowski  
Computational Neurobiology Lab  
The Salk Institute  
P. O. Box 85800  
San Diego, CA 92186

Dr. Michael Shadlin  
Department of Neurobiology  
Stanford Medical School  
Stanford, CA 94395

Dr. Michael Stryker  
Department of Physiology  
University of California  
School Of Medicine  
San Francisco, CA 94143-0444

Dr. David Tank  
AT&T Bell Laboratories  
Room 1C 427  
600 Mountain Avenue  
Murray Hill, NJ 07974

Dr. Daniel Ts'0  
Department of Neurobiology  
Rockefeller University  
Tower Building, Rm. 425  
1230 York Avenue  
New York, NY 10021

Dr. Steven Zucker  
Department of Electrical Engineering  
McGill University  
3480 University Street  
Montreal, Quebec H3A 2