

EMILIO BIZZI

Curriculum Vitae

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EDUCATION

- 1958 M.D., University of Rome, Rome Italy
- 1968 Docenza, (Italian equivalent of Ph.D.) University of Pisa, Pisa, Italy

ACADEMIC APPOINTMENTS

- 2002- Institute Professor, Massachusetts Institute of Technology, Cambridge, MA (MIT)
- 1997-02 Eugene McDermott Professor in the Brain Sciences and Human Behavior, MIT
- 1986-97 Chairman, Department of Brain and Cognitive Sciences, MIT, Cambridge, MA
- 1983-89 Director, Whitaker College of Health Sciences, Technology, and Management, MIT
- 1980-83 Eugene McDermott Professor in the Brain Sciences and Human Behavior, MIT
- 1972-80 Professor of Neurophysiology, Department of Psychology, MIT
- 1969-72 Associate Professor, Department of Psychology, MIT
- 1968-69 Senior Investigator, Istituto di Ricerche Cardiovascolari, University of Milan, Italy
- 1967-68 Lecturer, Department of Psychology, MIT
- 1966-67 Research Associate, Department of Psychology, MIT
- 1964-66 Visiting Associate, Section of Physiology, Laboratory of Clinical Science,
National Institute of Mental Health, Bethesda, MD
- 1963-64 Research Associate, Neurophysiological Laboratory, Department of Zoology, Washington
University, St. Louis, MO
- 1960-63 Post-Doctoral Fellow, Institute of Physiology, University of Pisa, Pisa, Italy
- 1958-60 Intern, Department of Internal Medicine, University of Siena Medical School, Italy

HONORS AND AWARDS

- ISSNAF Lifetime Achievement Award (2018)
- President, the American Academy of Arts and Sciences (2006-2009)
- President of Italy Gold Medal for achievements in science (2005)
- Empedocles Prize (2005)
- Degree "honoris causa" in Biomedical Engineering, University of Genova, Italy. (2004)
- Institute Professor, MIT (2002)
- Secretary of the American Academy of Arts and Sciences (1999)
- Eugene McDermott Professorship in the Brain Sciences and Human Behavior (1980-2002)
- Hermann von Helmholtz Award (1992)
- Trustee, Neurosciences Research Foundation, Inc. (1991-)
- Corporation Member, Boston Museum of Science (1989)
- Counselor, Society for Neuroscience (1988)
- NIH Javits Neuroscience Investigator Award (1988)
- Bartlett Lecturer (1988)
- NIH MERIT Award (1986)

Whitaker Health Sciences Award (1978-79, 1982-83)
Alden Spencer Award (1978)
Fellow, Foundation Fund for Research in Psychiatry (1968)
Medical degree with highest honors (summa cum laude) (1958)

ELECTED POSITIONS IN PROFESSIONAL ORGANIZATIONS

Accademia Nazionale Dei Lincei (Italian National Academy)
National Academy of Medicine (2005)
National Academy of Sciences (1986)
American Academy of Arts and Sciences (1980)
International Brain Research Organization (IBRO)

MEMBERSHIPS PROFESSIONAL ORGANIZATIONS

American Association for the Advancement of Science
Society for Neuroscience
Boston Society for Psychiatry and Neurology
American Academy of Clinical Neurophysiology

COMMITTEES

International Advisory Committee, Italian Institute of Technology (2011-present)
International Advisory Committee, SISSA, Trieste Italy (2010-2011)
Committee Chair – Neuroscience, Italian Institute of Technology, Genoa, Italy (2009-present)
Board of Scientific Directors, Institute for Scientific Information, Turin, Italy (2001-2006)
International Scientific Evaluation Committee, International Institute for Advanced Studies, Trieste, Italy (2001-2005)
Board of Scientific Directors, Bio3 Research, Milan, Italy (2001)
Associate, The Neurosciences Institute, San Diego, CA (1999)
Secretary, American Academy of Arts and Sciences (1998)
Professional Advisory Board, Bancroft Corporation (1998)
Chair, Class II Membership Committee, American Academy of Arts and Sciences (1995-98)
Member, Harvard University Division of Physical Medicine and Rehabilitation (1994-)
Trustee, Neurosciences Research Foundation, Inc. (1991-1999)
Advisory Board, Charlestown MGH Center for Integrative Psychiatry
Advisory Board, McDonnell-Pew Program in Cognitive Neuroscience (1990)
Board of Scientific Advisors, Center for Neural Science, New York University (1986)
Member of N.I.H. Study Section Vision B (1973-1977)

EDITORIAL BOARDS

Journal of Motor Behavior; Journal of Cognitive Neuroscience; Journal of Neuroscience;
Behavioural Brain Research; Somatosensory and Motor Research; Current Opinion in
Neurobiology; Cognitive Brain Research

PATENT: System for Human Trajectory Learning in Virtual Environments, #5,554,033
Date: September 10, 1996

PUBLICATIONS

Dr. Bizzi has published over 200 articles in refereed journals, book chapters and abstracts. He has been an invited participant in both national and international conferences. His publications include:

Bizzi, E. (2019) NEUROSCIENCE FOR AN ARTIST; A BEGINNING A book chapter based on the IEA conference: "Space-time geometries in the brain and movement in the arts" Paris, France, 2018 In press, Springer Publishing

Rossi F., Motto Ros P., Sapienza S., Bonato P., Bizzi E., Demarchi D. (2019) Wireless Low Energy System Architecture for Event-Driven Surface Electromyography. In: Saponara S., De Gloria A. (eds) Applications in Electronics Pervading Industry, Environment and Society. ApplePies 2018. Lecture Notes in Electrical Engineering, vol 550. Springer, Cham

Saltiel, P., d'Avella, A., Tresch, M.C., Wyler, K. and Bizzi, E., 2017. Critical points and traveling wave in locomotion: experimental evidence and some theoretical considerations. *Frontiers in neural circuits*, 11, p.98.

Bizzi, E. (2016) Motor control revisited: A novel view. *Current Trends in Neurology*. Volume 10, Page 75.

Lencioni, T., Jonsdottir, J., Cattaneo, D., Crippa, A., Gervasoni, E., Rovaris, M., Bizzi, E., Ferrarin, M. (2016) Are Modular Activations Altered in Lower Limb Muscles of Persons with Multiple Sclerosis during Walking? Evidence from Muscle Synergies and Biomechanical Analysis. *Frontiers in Human Neuroscience* Volume 10 | Article 620, doi: 10.3389/fnhum.2016.00620

Caggiano, V., Cheung, V. C., & Bizzi, E. (2016) An Optogenetic Demonstration of Motor Modularity in the Mammalian Spinal Cord. *Scientific Reports Nature Group*, 6, 35185.

Flash, T., Bizzi, E. (2016). Cortical circuits and modules in movement generations: experiments and theories. *Current Opinion in Neurobiology*, Volume 41, December 2016, Pages 174-178

Saltiel, P., d'Avella, A., Wyler-Duda, K., Bizzi, E. (2016) Synergy temporal sequences and topography in the spinal cord: evidence for a traveling wave in frog locomotion. *Brain Struct Funct* Nov 221(8):3869-3890 DOI 10.1007/s00429-015-1133-5

Bizzi, E., Ajemian, R. (2015) A Hard Scientific Quest: Winter 2015 Understanding Voluntary Movements. *Daedalus* doi:10.1162/DAED_a_00324

Overduin, S., d'Avella, A., Roh, J., Carmena, J. and Bizzi, E. (2015) Representation of Muscle Synergies in the Primate Brain" *Journal of Neuroscience* 35(37):12615-12624.

Lu, C., Froriep, U.P., Koppes, R.A., Canales, A., Caggiano, V., Selvidge, J. Bizzi, E., Anikeeva, P., (2014) Flexible Fibers: Polymer Fiber Probes Enable Optical Control of Spinal Cord and Muscle Function In Vivo (Adv. Funct. Mater. 42/2014) *Advanced Functional Materials* 11/2014; 24(42):6732. 10.44 Impact Factor

Caggiano, V., Sur, M., Bizzi, E. 2014 Rostro-Caudal Inhibition of Hindlimb Movements in the Spinal cord of Mice, *PLoS ONE*, 9(6): e100865. Doi: 10.1371/journal.pone.00100865 MIT News. *Wired it. (Italian)*

Overduin, S., D'Avella, A., Carmena, J., Bizzi, E. (2014) Muscle synergies evoked by microstimulation are preferentially encoded during behavior. *Frontiers in Computational Neuroscience*, 8:20.

Ajemian, R., Bizzi, E. (2013) A theory for how sensorimotor skills are learned and retained in noisy and nonstationary neural circuits. *Proc Natl Acad Sci*, 2013 110 (52) E5078-E5087; published ahead of print December 9, 2013, doi:10.1073/PNAS.1320116110

Overduin, S, d'Avella, A, Carmena, J, Bizzi, E. (2012) Microstimulation Activates a Handful of Muscle Synergies. *NEURON-76: 1071-1077 (given a Preview by Diedrichsen J & Classen J in the same issue).*

Bizzi, E., Cheung, V.C.K., (2013) The Neural Origin of Muscle Synergies. *Frontiers in Computational Neuroscience; Volume 7/Article 51/1.*

Cheung, V, Turolla, A, Agostini, M, Silvoni, S, Bennis, C, Kasi, P, Paganoni, S, Bonato, P, Bizzi, E. (2012) Muscle synergy patterns as physiological markers of motor cortical damage. *Proc Natl Acad Sci* 109 (36) 14652-14656; published ahead of print August 20, 2012, doi:10.1073/pnas.1212056109

Richardson, AG, Borghi, T, Bizzi, E. (2012) Activity of the same motor cortex neurons during repeated experience with perturbed movement dynamics. *J Neurophysiology* 107:3144-3154; published ahead of print March 28, 2012, doi:10.1152/jn.00477.2011

Roh, J., Cheung, V.C.K., Bizzi, E., (2011) Modules in the Brainstem and Spinal Cord Underlying Motor Behaviors. *J. Neurophysiology; 106(3):1363-78. Epub 2011 Jun 8.*

Ajemian, R., D'Ausilio, A., Moorman, H., Bizzi, E. (2010) Why Professional Athletes Need a Prolonged Period of Warm-Up and Other Peculiarities of Human Motor Learning. *J. Motor Behavior: Vol. 42:6; 381-388*

Overduin SA, Zaheer F, Bizzi E, d'Avella A. (2010) An instrumented glove for small primates. *J Neurosci Methods; 187(1):100-4. Epub 2009 Dec 23.*

Overduin SA, Richardson AG, Bizzi E. (2009) Cortical processing during dynamic motor adaptation. *Adv Exp Med Biol.; 629:423-38.*

- Cheung, V.C.K., Piron, L., Agostini, M., Silvoni, S., Turolla, A., Bizzi, E. (2009) Stability of muscle synergies for voluntary actions after cortical stroke in humans *Proc Natl Acad Sci* 106:19563-19568.
- Berniker, M., Jarc, A., Bizzi, E., Tresch, M. (2009) Simplified and effective motor control based on muscle synergies to exploit musculoskeletal dynamics. *Proc Natl Acad Sci* 106:7601-7606.
- Cheung, V.C.K., d'Avella, A., Bizzi, E. (2009) Adjustments of Motor Pattern for Load Compensation Via Modulated Activations of Muscle Synergies During Natural Behaviors *J Neurophysiol*, 101: 1235 - 1257.
- Richardson, A., Lassi-Tucci, G., Padoa-Schioppa, C., Bizzi, E. (2008) Neuronal activity in the cingulate motor areas during adaptation to a new dynamic environment. *J. Neurophysiol*, 99:1253-1266.
- Overduin, S., d'Avella, A., Roh, J., Bizzi, E., (2008) Modulation of muscle synergy recruitment in primate grasping. *J. Neurosci*, 28(4):880-92.
- Bizzi, E., Cheung, V.C.K., d'Avella, A., Saltiel, P., Tresch, M. (2008) Combining Modules for Movement, *Brain Research Reviews*, 57:125-133.
- Overduin, S., Richardson, A., Bizzi, E., Press, D. (2007) Simultaneous sensorimotor adaptation and sequence learning. *Exp Brain Res.*, 184(3):451-6.
- Rokni, U., Richardson, A.G., Bizzi, E., Seung, S., (2007) Motor learning with unstable neural representations. *Neuron*, 54(4):653-66
- Richardson, A., Overduin, S., Valero-Cabre, A., Padoa-Schioppa, C., Pascual-Leone, A., Bizzi, E., Press, D., (2006) Disruption of primary motor cortex prior to learning impairs memory of movement dynamics, *J. Neurosci*, 26(48):12466-70.
- Overduin, S., Richardson, A., Lane, C, Bizzi, E., Press, D. (2006) Intermittent practice facilitates stable motor memories. *J. Neurosci*, 26(46):11888-92.
- Xiao, J., Padoa-Schioppa, C., Bizzi, E. (2006) Neuronal Correlates of Movement Dynamics of the Dorsal Premotor Area and Ventral Premotor Area in the Monkey", *Exp Brain Research*, 168 (1-2):106-19.
- Saltiel, P., Wyler-Duda, K., d'Avella, A., Ajemian, R.J., and Bizzi, E. (2005) Localization and connectivity in spinal interneuronal networks: the adduction-caudal extension-flexion rhythm in the frog. *J. Neurophysiol*, 94: 2120-2138.
- Cheung, V. C.K., d'Avella, A., Tresch, M.C., and Bizzi, E. (2005) Central and Sensory Contributions to the Activation and Organization of Muscle Synergies during Natural Motor Behaviors, *J. Neurosci*, 25:6419-6434.

Richardson, A., Slotine, J.J., Bizzi, E., Tresch, M.C. (2005) Intrinsic musculoskeletal properties stabilize wiping movements in the spinalized frog, *J. Neurosci*, 25(12):3181-91

Holden, M., Dyar, T., Schwamm, L., Bizzi, E. (2005) Virtual-Environment-Based Telerehabilitation in Patients with Stroke. *Presence*, 14 (2): 214-233

d'Avella, A., Bizzi, E. (2005) Shared and specific muscle synergies in natural motor behaviors. *Proc Natl Acad Sci*, 102(8): 3076-3081.

Poggio, T. Bizzi, E. (2004) Learning and generalization in vision and motor control. *Insight Review Article, Nature*, 431: 768-774.

Padoa-Schioppa, C., Li, C-S, R , Bizzi, E. (2004) Neuronal Activity in the Supplementary Motor Area of Monkeys Adapting to a New Dynamic Environment. *J Neurophysiol*, 91: 449-473.

d'Avella, A., Saltiel, P., Bizzi, E. (2003) Combinations of muscle synergies in the construction of a natural motor behavior. *Nature Neuroscience*, 6(3): 300-308.

Padoa-Schioppa, C., Li, C-S R., Bizzi, E., (2002) Neuronal Correlates of Kinematics-to-Dynamics Transformation in the Supplementary Motor Area. *Neuron*, 36: 751-765.

Tresch, M.C., Saltiel, P., d'Avella, A., Bizzi, E. (2002) Coordination and localization in spinal motor systems. *Brain Research Reviews*, 40: 66-79.

Bizzi, E., d'Avella, A., Saltiel, P., Tresch, M. (2002) Modular Organization of Spinal Motor Systems. *Neuroscientist*, 8(5): 437-442. *Review*

Li, C-S.R., Padoa Schioppa, C., Bizzi, E. (2001) Neuronal Correlates of Motor Performance and Motor Learning in the Primary Motor Cortex of Monkeys Adapting to an External Force Field. *Neuron*, 30: 593-607.

Lemay, M.A., Galagan, J.E., Hogan, Bizzi, E. (2001) Modulation and Vectorial Summation of the Spinalized Frog's Hindlimb End-Point Force Produced by Intraspinal Electrical Stimulation of the Cord. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 9(1): 12-23.

Saltiel, P., Wyler-Duda, K., d'Avella, A., Tresch, M, and Bizzi, E. (2001) Muscle synergies encoded within the spinal cord: evidence from focal intraspinal NMDA iontophoresis in the frog. *J. Neurophysiology*, 85(2): 605-619.

Holden, M.K., Dettwiler, A., Dyar, T., Niemann, G., Bizzi, E. (2001) Retraining Movement in Patients with Acquired Brain Injury using a Virtual Environment. *Medicine Meets Virtual Reality, J.D. Wetwood et al (Eds.) IOS Press*, 192-198.

Giszter, S.F., Loeb, E., Mussa-Ivaldi, F.A., Bizzi, E. (2000) Repeatable spatial maps of a few force and joint torque patterns elicited by microstimulation applied throughout the lumbar spinal cord of the spinal frog. *Human Movement Science*, 19: 597-626.

- Bizzi, E., Tresch, M.C., Saltiel, P. and d'Avella, A. (2000) New Perspectives on Spinal Motor Systems. *Nature Reviews/Neuroscience*, 1: 101-108.
- Loeb, E., Giszter, S., Satiel, P., Mussa-Ivaldi, F.A., Bizzi, E. (2000) Output units of motor behavior: An experimental and modeling study. *J. Cognitive Neuroscience*, 12(1): 78-97.
- Mussa-Ivaldi, F.A., and Bizzi, E. (2000) Motor learning through the combination of primitives. *Phil. Trans. R. Soc. Lond. B.*, 355: 1755-1769.
- Gandolfo, F., Li, C.-S.R., Benda, B.J., Padoa Schioppa, C., and Bizzi, E. (2000) Cortical correlates of learning in monkeys adapting to a new dynamical environment. *Proc Natl Acad Sci*, 97(5): 2259-2263.
- Bizzi, E. and Mussa-Ivaldi, F.A. (1999) Apprendimento e controllo degli atti motori, *Estratto Dal Volume III*, 137-153.
- Bizzi, E. and Clarac, F. (1999) Motor Systems. *Curr. Opinion in Neurobiology*, 9 (6): 659-662.
- Bizzi, E. and Mussa-Ivaldi, F.A. (1999) Toward a Neurobiology of Coordinate Transformations. *The New Cog. Neuroscience. MIT Press, Cambridge, MA.*, 489-500.
- Holden, M., Todorov, E., Callahan, J., and Bizzi, E. (1999) Virtual Environment Training Improves Motor Performance with Stroke: *Case Report. Neuro. Rep.*, 23(9): 57-67.
- Tresch, M.C., and Bizzi, E. (1999) Responses from the spinal microstimulation in the chronically spinalized rats and their relationship to spinal systems activated by low threshold cutaneous stimulation. *Exp. Brain Research*, 129: 401-416.
- Tresch, M.C., Saltiel, P., and Bizzi, E. (1999) The construction of movement by the spinal cord. *Nature Neuroscience*, 2: 162-167.
- Bizzi, E., Saltiel, P., and Tresch, M.C. (1998) Modular organization of motor behavior. *Zeitschrift für Naturforschung*, 53c: 510-517.
- d'Avella, A. and Bizzi, E. (1998) Low dimensionality of supraspinally induced force fields. *Proc Natl Acad Sci.*, 95: 7711-7714.
- Saltiel, P., Tresch, M.C. and Bizzi, E. (1998) Spinal cord modular organization and rhythm generation: an NMDA iontophoretic study in the frog. *J. Neurophysiol.*, 80: 2323-2339.
- Bizzi, E. and Mussa-Ivaldi, F.A. (1998) The acquisition of motor behavior. *Daedalus*, 127: 217-232.
- Bizzi, E. and Mussa-Ivaldi, F.A. (1998) Neural basis of motor control and its cognitive implications. *Trends in Cognitive Science*, 2 (3): 97-102.

- Todorov, E., Shadmehr, R. and Bizzi, E. (1997) Augmented feedback presented in a virtual environment accelerated learning of a difficult motor task. *J. Motor Behavior*, 29 (2): 147-158.
- McIntyre, J., Mussa-Ivaldi, F.A. and Bizzi, E. (1996) The control of stable postures in the multi-joint arm. *Exp. Brain Res., Brain Res.*, 110: 248-264.
- Brashers-Krug, T., Shadmehr, R. and Bizzi, E. (1996) Consolidation in human motor learning. *Nature*, 382: 252-255.
- Gandolfo, F., Mussa-Ivaldi, F.A. and Bizzi, E. (1996) Motor learning by field approximation. *Proc. of the National Academy of Science*, 93: 3843-3846.
- Bizzi, E., Giszter, S.F., Loeb, E., Mussa-Ivaldi, F.A. and Saltiel, P. (1995) Modular organization of motor behavior in the frog's spinal cord. *Trends in NeuroSci.*, 18: 442-445.
- Mussa-Ivaldi, F.A., Giszter, S.F. and Bizzi, E. (1994) Linear combinations of primitives in vertebrate motor control. *Proc. of the National Academy of Science*, 91: 7534-7538.
- Dornay, M., Mussa-Ivaldi, F.A., McIntyre, J. and Bizzi, E. (1993) Stability constraints for the equilibrium-point hypothesis. *Neural Networks*, 6: 1045-1059.
- Bizzi, E. (1993) Intermediate representations in the formation of arm trajectories. *Current Opinion on Neurobiol.*, 3: 925-931.
- McIntyre, J. and Bizzi, E. (1993) Servo models for the biological control of movement. *J. Motor Behav.*, 25: 193-202.
- Loeb, E.P., Giszter, S.F., Borghesani, P. and Bizzi, E. (1993) Effects of dorsal root cut on the forces evoked by spinal microstimulation in the spinalized frog. *Somatosensory & Motor Res.*, 10: 81-95.
- Shadmehr, R., Mussa-Ivaldi, F.A. and Bizzi, E. (1993) Postural force fields of the human arm and their role in generating multi-joint movements. *J. Neurosci.*, 13: 45-62.
- Giszter, S., Mussa-Ivaldi, F.A. and Bizzi, E. (1993) Convergent force fields organized in the frog's spinal cord. *J. Neurosci.*, 13: 467-491.
- Bizzi, E., Hogan, N, Mussa-Ivaldi, F.A. and Giszter, S. (1992) The equilibrium-point framework: A point of departure. *Behavioral and Brain Sciences*, 15: 808-815.
- Bizzi, E., Hogan, N, Mussa-Ivaldi, F.A. and Giszter, S. (1992) Does the nervous system use equilibrium-point control to guide single and multiple joint movements? *Behavioral and Brain Sciences*, 15: 603-613.
- Mussa-Ivaldi, F.A., Bizzi, E. and Giszter, S.F. (1991) A field-approximation approach to the execution of motor plans. *Fifth International Conference on Advanced Robotics (ICAR)* 1200-1204.

Mussa-Ivaldi, F.A., Bizzi, E. and Giszter, S.F. (1991) Transforming plans into actions by tuning passive behavior: a field-approximation approach. *Proc. IEEE International Symposium on Intelligent Control (ISIC 91)*, 101-109.

Bizzi, E., Mussa-Ivaldi, F.A. and Giszter, S. (1991) Computations underlying the execution of movement: a novel biological perspective. *Science*, 253: 287-291.

Mussa-Ivaldi, F.A., Giszter, S.F. and Bizzi, E. (1990) Motor-space coding in the central nervous system. *Cold Spring Harbor Symp. on Quantitative Biology*, 55. Cold Spring Harbor Laboratory Press, N.Y., 827-835.

Massone, L. and Bizzi, E. (1990) On the role of input representations in sensorimotor mapping. *Proc. IJCNN*, 1: 173-176.

Bizzi, E. and Mussa-Ivaldi, F. (1990) Intelligenza motoria: vincoli fisici e problemi computazionali. *Sistemi Intelligenti*, 2: 37-55.

Bizzi, E. (1990) Motor control in biological and artificial systems. *Sfera*, 10: 65-66.

Massone, L. and Bizzi, E. (1989) A neural network model for limb trajectory formation. *Biol. Cybern.*, 61: 417-425.

Giszter, S.F., McIntyre, J. and Bizzi, E. (1989) Kinematic strategies and sensorimotor transformations in the wiping movements of frogs. *J. Neurophysiol.*, 62: 750-767.

Bizzi, E., Mussa-Ivaldi, F.A. and Hogan, N. (1986) Regulation of multi-joint arm posture and movement. *Prog. in Brain Res.*, 64: 345-351.

Mussa-Ivaldi, F.A., Hogan, N. and Bizzi, E. (1985) Neural, mechanical and geometric factors subserving arm posture in humans. *J. Neurosci.*, 5: 2732-2743.

Bizzi, E., Accornero, N., Chapple, W. and Hogan, N. (1984) Posture control and trajectory formation during arm movement. *J. Neurosci.*, 4: 2738-2744.

Whittington, D., Lestienne, F. and Bizzi, E. (1984) Behavior of preoculomotor burst neurons during eye-head coordination. *Exp. Brain Res.*, 55: 215-222.

Bizzi, E., Chapple, W. and Hogan, N. (1982) Muscles as springs: implications for motor control. *Trends in Neurosci.*, 5: 395-398.

Abend, W.K., Bizzi, E. and Morasso, P. (1982) Human arm trajectory formation. *Brain*, 105: 331-348.

Bizzi, E., Accornero, N., Chapple, W. and Hogan, N. (1982) Arm trajectory formation. *Exp. Brain Res.*, 46: 139-143.

Lestienne, F., Polit, A. and Bizzi, E. (1981) Functional organization of the motor process underlying the transition from movement to posture. *Brain Res.*, 230: 121-131.

- Bizzi, E. and Polit, A. (1979) Processes controlling visually evoked movements. *Neuropsychologia*, 17: 203-213.
- Polit, A. and Bizzi, E. (1979) Characteristics of the motor programs underlying arm movements in monkeys. *J. Neurophysiol.*, 42: 183-194.
- Lestienne, F., Polit, A. and Bizzi, E. (1978) Processus de transition entre le mouvement et la posture: etude electromyographique chez l'homme. *J. Physiol. (Paris)*, 74: 72P.
- Polit, A. and Bizzi, E. (1978) Processes controlling arm movements. *Science*, 201: 1235-1237.
- Lanman, J., Bizzi, E. and Allum, J.H.J. (1978) The coordination of eye and head movements during smooth pursuit. *Brain Res.*, 153: 39-53.
- Bizzi, E., Dev, P., Morasso, P. and Polit, A. (1978) The effect of load disturbances during centrally initiated movements. *J. Neurophysiol.*, 41: 542-556.
- Bizzi, E., Polit, A. and Morasso, P. (1976) Mechanisms underlying achievement of final position. *J. Neurophysiol.*, 39: 435-444.
- Polit, A., Bizzi, E. and Morasso, P. (1975) Mechanisms of head movement termination during orientation. *Brain Theory Newsletter*, 1: 7-9.
- Bizzi, E. (1974) Common problems confronting eye movement physiologists and investigators of somatic motor functions. *Brain Res.*, 71: 191-194.
- Bizzi, E. (1974) The coordination of eye-head movements. *Sci. Am.*, 231: 100-106.
- Dichgans, J., Bizzi, E., Morasso, P. and Tagliasco, V. (1974) The role of vestibular and neck afferents during eye-head coordination in the monkey. *Brain Res.*, 71: 225-232.
- Dichgans, J., Bizzi, E., Morasso, P. and Tagliasco, V. (1973) Mechanisms underlying recovery of eye-head coordination following bilateral labyrinthectomy in monkeys. *Exp. Brain Res.*, 18: 548-562.
- Morasso, P., Bizzi, E. and Dichgans, J. (1973) Adjustment of saccade characteristics during head movements. *Exp. Brain Res.*, 16: 492-500.
- Bizzi, E., Kalil, R.E. and Morasso, P. (1972) Two modes of active eye-head coordination in monkeys. *Brain Res.*, 40: 45-48.
- Bizzi, E., Kalil, R.E. and Tagliasco, V. (1971) Eye-head coordination in monkeys: evidence for centrally patterned organization. *Science*, 173: 452-454.
- Bizzi, E. and Evarts, E.V. (1971) Translational mechanisms between input and output. *Neurosci. Res. Prog. Bull.*, 9: 31-59.

- Bizzi, E. and Schiller, P. (1970) Single unit activity in the frontal eye fields of unanesthetized monkeys during eye and head movements. *Exp. Brain Res.*, 10: 151-158.
- Bizzi, E. (1968) Discharge of frontal eye field neurons during saccadic and following eye movements in unanesthetized monkeys. *Exp. Brain Res.*, 6: 69-80.
- Bizzi, E. (1967) Discharge of frontal eye field neurons during eye movements in awake monkeys. *Science*, 157: 1588-1590.
- Bizzi, E. (1966) Discharge patterns of single geniculate neurons during the rapid eye movements of sleep. *J. Neurophysiol.*, 29: 1087-1095.
- Bizzi, E. (1966) Changes in the orthodromic and antidromic response of optic tract during the eye movements of sleep. *J. Neurophysiol.*, 29: 861-870.
- Bizzi, E., Pompeiano, O. and Somogyi, I. (1964) Vestibular nuclei: activity of single neurons during natural sleep and wakefulness. *Science*, 145: 414-415.
- Bizzi, E., Pompeiano, O. and Somogyi, I. (1964) Spontaneous activity of single vestibular neurons of unrestrained cats during sleep and wakefulness. *Arch. Ital. Biol.*, 102: 308-330.
- Malliani, A., Bizzi, E., Apfelbaum, J. and Zanchetti, A. (1963) Ascending afferent mechanisms maintaining sham rage behavior in the acute thalamic cat. *Arch. Ital. Biol.*, 101: 632-647.
- Brooks, D.C. and Bizzi, E. (1963) Brain stem electrical activity during deep sleep. *Arch. Ital. Biol.*, 101: 648-665.
- Bizzi, E., Malliani, A., Apfelbaum, J. and Zanchetti, A. (1963) Excitation and inhibition of sham rage behavior in lower brain stem stimulation. *Arch. Ital. Biol.*, 101: 614-631.
- Bizzi, E. and Brooks, D.C. (1963) Functional connections between pontine reticular formation and lateral geniculate nucleus during deep sleep. *Arch. Ital. Biol.*, 101: 666-680.
- Bizzi, E. and Brooks, D.C. (1963) Pontine reticular formation: relation to lateral geniculate nucleus during deep sleep. *Science*, 171: 270-272.
- Bizzi, E. and Spencer, W.A. (1962) Enhancement of EEG synchrony in the acute "cerveau isole". *Arch. Ital. Biol.*, 100: 234-247.
- Bizzi, E., Libretti, A., Malliani, A. and Zanchetti, A. (1961) Reflex chemoceptive excitation of diencephalic sham rage behavior. *Am. J. Physiol.*, 200: 923-926.
- Bartorelli, C., Bizzi, E., Libretti, A. and Zanchetti, A. (1960) Inhibitory control of sinocarotid pressoreceptive afferents on hypothalamic autonomic activity and sham rage behavior. *Arch. Ital. Biol.*, 98: 308-326.

BOOKS

Bizzi, E., (Invited Contributor) (2009) *The History of Neuroscience in Autobiography*, Volume 6, Oxford University Press. This book is the sixth volume of autobiographical essays by distinguished senior neuroscientists. The contributors, all notable scientists, discuss major events that shaped their discoveries and their influences, as well as people that inspired them and help shape their careers as neuroscientists.

Bizzi, E., Mussa-Ivaldi, F.A. (2009) Neurobiology of Coordinate Transformations. Chapter 37, *The Cognitive Neurosciences 4th Ed*, MIT Press, Cambridge, MA, 541-551, ISBN 978-0-262-01341-3.

Overduin, S.A., Richardson, A.G., Bizzi, E. (2009) Neural correlates and psychophysics of dynamic motor adaptation. *Progress in Motor Control – A multidisciplinary perspective*. Sternad, Dagmar (Ed.) New York: Springer. 2009, XVIII, pps. 423-438. ISBN: 978-0-387-77063-5

Padoa-Schioppa, C., Mussa-Ivaldi, F.A., Bizzi, E. (2005) Motor Cortex in Voluntary Movements; *Frontiers in Neuroscience*, Alexa Riehle and Eilon Vaadia, Eds. Chapter 12, Cortical Control of Motor Learning. CRC Press. 329-346, ISBN 0-8493-1287-6.

Bizzi, E., Mussa-Ivaldi, F.A. (2004) Toward a neurobiology of coordinate transformations. Chapter 30, *The Cognitive Neurosciences III*, MIT Press, Cambridge, MA, 413-474, 0-262-07254-8.

Padoa-Schioppa, C., Bizzi, E. (2003) Taking action: cognitive neuroscience perspectives on intentional acts. Chapter 11, *Neuronal Plasticity in the Motor Cortex of Monkeys Acquiring a New Internal Model*. MIT Press, Cambridge, MA, 341-360, 0-262-10097-5.

Bizzi, E., Mussa-Ivaldi, F.A. (2000) Toward a neurobiology of coordinate transformations. Chapter 34, *The New Cognitive Neurosciences*, MIT Press,, Cambridge, MA, 489-500, 0-262-07195-9.

Mussa-Ivaldi, F.A. and Bizzi, E. (1997) Learning Newtonian mechanics. In: P. Morasso and V. Sanguineti (Eds.), *Self-Organization, Computational Maps and Motor Control*. Elsevier, Amsterdam, in press.

Bizzi, E. and Mussa-Ivaldi, F.A. (1994) Toward a neurobiology of coordinate transformation. In: M. Gazzaniga (Ed.,) *The Cognitive Neurosciences*. MIT Press, Cambridge, MA, 495-506.

Bizzi, E. (1994) Introduction. Overview of sensory motor integration. In: M. Gazzaniga (Ed.,) *The Cognitive Neurosciences*. MIT Press, Cambridge, MA, 491-493.

Mussa-Ivaldi, F.A. and Bizzi, E. (1993) Structural constraints and computational problems in motor control. In: P. Dario, G. Sandini and P. Aebischer (Eds.), *Robots and Biological Systems: Towards a New Bionics?* NATO ASI Series F 102. Springer-Verlag Publishing Co., N.Y., 339-360.

Giszter, S.F., Bizzi, E. and Mussa-Ivaldi, F.A. (1993) Movement primitives in the frog spinal cord. In F.H. Eeckman (Ed.), *Analysis and Modeling of Neural Systems, II*. Kluwer Academic Publishers, Boston, MA, 431-446.

Giszter, S.F., Bizzi, E. and Mussa-Ivaldi, F.A. (1992) Motor organization in the frog's spinal cord. In F.H. Eeckman (Ed.), *Analysis and Modeling of Neural Systems*. Kluwer Academic Publishers, Boston, MA, 377-392.

Giszter, S., Mussa-Ivaldi, F.A. and Bizzi, E. (1992) The organization of limb motor space in the spinal cord. In: R. Caminiti, P.B. Johnson and Y. Burnod (Eds.), *Control of Arm Movement in Space Neurophysiological and Computational Approaches*. Exp. Brain Res. Series 22. Springer-Verlag, Berlin, 321-331.

Giszter, S.F., Mussa-Ivaldi, F.A. and Bizzi, E. (1992) Equilibrium point mechanisms in the spinal frog. In: M. Arbib and J.P. Ewert (Eds.), *Visual Structures and Integrated Functions*. Springer-Verlag, N.Y., 223-237.

Mussa-Ivaldi, F.A., Morasso, P., Hogan, N. and Bizzi (1991) Network models of motor systems with many degrees of freedom. In: M.D. Fraser (Ed.), *Advances in Control Networks and Large-Scale Parallel-Distributed Processing Models*, 1. Ablex Publishing Co.: Norwood, N.J., 171-220.

Bizzi, E. and Mussa-Ivaldi, F.A. (1990) Muscle properties and the control of arm movements. In: D. Osherson, S. Kosslyn and J. Hollerbach (Eds.), *Visual Cognition and Action An Invitation to Cognitive Science*, Vol. 2. The MIT Press: Cambridge, MA, 213-242.

Bizzi, E. (1989) Brain and motor control. In: Y. Christen and K. Klivington (Eds.), *Les Enigmes du Cerveau*. Editions Hologramme: Paris, 142-143.

Bizzi, E. and Mussa-Ivaldi, F.A. (1989) Theoretical and experimental approaches to biological motor control. In: A. Baruzzi, C. Franzini, E. Lugaesi and P.L. Parmeggiani (Eds.), *From Luigi Galvani to Contemporary Neurobiology*. Fidia Research Series, Vol. 22, 39-57.

Bizzi, E. and Mussa-Ivaldi, F. A. (1989) Emergent issues in the control of multi-joint movements. In: L. Deecke (Ed.), *From Neuron to Action*. Springer-Verlag: Heidelberg, 19-28.

Bizzi, E. and Mussa-Ivaldi, F.A. (1989) Motor Control. In: F. Bollar and F. Grafman (Eds.), *Handbook of Neuropsychology*, Vol. 2. Elsevier Science Pubs. Biomedical Division: The Netherlands, 229-244.

Bizzi, E. and Mussa-Ivaldi, F.A. (1989) Geometrical and mechanical issues in movement planning and control. In: M.I. Posner (Ed.), *Foundations of Cognitive Science*. The MIT Press/Bradford Books: Cambridge, MA, 769-792.

Mussa-Ivaldi, F.A., McIntyre, J. and Bizzi, E. (1988) Theoretical and experimental perspectives on arm trajectory formation: A distributed model of motor redundancy. In: E. Clementi and S. Chin (Eds.), *Biological and Artificial Intelligence Systems*. Escom: Leiden, 563-577.

Bizzi, E. (1988) Arm trajectory planning and execution: the problem of coordinate transformation. In: P. Rakic and W. Singer (Eds.), *Neurobiology of Neocortex*. John Wiley & Sons Limited: Berlin, FRG, 371-381.

Bizzi, E. (1987) Motor control mechanisms: an overview. In: L. Scheinberg and B. Shahani (Eds.), *Neurological Clinics*. W.B. Saunders Co.: Philadelphia, PA, 523-528.

Bizzi, E. (1987) Multi-joint arm posture. New perspectives on the control of arm posture and movement. In: A. Struppler and A. Weindl (Eds.), *Sensory Motor Integration - Implications for Neurological Disease*. Springer-Verlag: N.Y., 291-296.

Bizzi, E. (1987) Eye-head coordination. In: G. Adelman (Ed.), *Encyclopedia of Neuroscience*. Birkhauser Boston Inc.: Cambridge, MA, 1362-1366.

Hogan, N., Bizzi, E., Mussa-Ivaldi, F.A. and Flash, T. (1987) Controlling multi-joint motor behavior. In: K.B. Pandolf (Ed.), *Exercise and Sport Sciences Reviews*. Macmillan Publ. Co.: N.Y., Chapter 6: 153-190.

Hocherman, S., Bizzi, E., Hogan, N. and Mussa-Ivaldi, F.A. (1986) Target acquisition and maintenance in two joint arm movements. In: R.S. Schmidt and M. Jeannerod (Eds.), *Sensorimotor Plasticity, Theoretical and Clinical Aspects*. Les Editions Inserm: Paris, 433-446.

Bizzi, E. and Abend, W.K. (1985) Control of multi-joint movement. In: F. Strumwasser and M. Cohen (Eds.), *Comparative Neurobiology: Modes of Communication in the Nervous System*. John Wiley & Sons, Inc., Publ.: N.Y., 255-277.

Bizzi, E. and Abend, W.K. (1983) Posture control and trajectory formation in single- and multi-joint arm movements. In: J. Desmedt (Ed.), *Motor Control Mechanisms in Health and Disease*. Raven Press: N.Y., 31-45.

Bizzi, E. (1983) Central processes involved in arm movement control. In: P.F. MacNeilage (Ed.), *The Production of Speech*. Springer-Verlag: N.Y., 3-10.

Lestienne, F., Whittington, D.A. and Bizzi, E. (1983) The coordination of eye-head movements in alert monkeys: behaviour of eye-related neurons in the brainstem. In: A. Hein and M. Jeannerod (Eds.), *Spatially Oriented Behavior*. Springer-Verlag: N.Y., 105-118.

Lestienne, F., Whittington, D.A. and Bizzi, E. (1982) Single cell recording from the pontine reticular formation (PRF) in monkeys: behaviour of preoculomotor neurons during eye-head coordination. In: A. Fuchs and W. Becker (Eds.), *Progress in Oculomotor Research*. Elsevier: N.Y., 325-333.

- Bizzi, E., Accornero, N., Chapple, W. and Hogan, N. (1982) Central and peripheral mechanisms in motor control. In: R.A. Thompson and J.R. Green (Eds.), *New Perspectives in Cerebral Localization*. Raven Press: N.Y., 23-34.
- Lestienne, F. and Bizzi, E. (1982) Processus du controle du mouvement et de sa position finale au cours d'une tache de pointage. In: H. Ripoll and G. Azemar (Eds.), *Neurobiologie des Comportements Moteurs*. I.N.S.E.P. Publs., Paris, France, 101-122.
- Lestienne, F., Whittington, D. and Bizzi, E. (1982) Behavior of pontine cells during eye-head coordination: evidence of gaze shift coding by preoculomotor bursters. In: A. Roucoux and M. Crommelinck (Eds.), *Physiological and Pathological Aspects of Eye Movements*. Dr. W. Junk Publs., The Hague, The Netherlands, 399-410.
- Bizzi, E. (1981) Visuomotor control as a computational problem. In: W.E. Reichard and T. Poggio (Eds.), *Theoretical Approaches in Neurobiology*. The MIT Press: Cambridge, MA, 177-183.
- Bizzi, E., Accornero, N., Chapple, W. and Hogan, N. (1981) Processes underlying arm trajectory formation. In: C. Ajmone-Marsden and O. Pompeiano (Eds.), *IBRO Monograph Series, Brain Mechanisms of Perceptual Awareness and Purposeful Behavior*. Raven Press: N.Y., 311-318.
- Bizzi, E. (1981) Eye-head coordination. In: V.B. Brooks (Ed.), *Handbook of Physiology*, 3. American Physiological Society: Bethesda, Md., 1321-1336.
- Lestienne, F., Polit, A. and Bizzi, E. (1980) From movement to posture. In: C.H. Nadeau, K.M. Newell, G.C. Roberts and W. Halliwell (Eds.), *Psychology of Motor Behavior and Sport*. Human Kinetics Publs.: Champaign, Ill., 390-399.
- Bizzi, E. (1980) Central and peripheral mechanisms in motor control. In: G.E. Stelmach and J. Requin (Eds.), *Tutorials in Motor Behavior*. North-Holland Publ. Co., The Netherlands, 131-143.
- Bizzi, E. (1979) Strategies of eye-head coordination. In: R. Granit and O. Pompeiano (Eds.), *Reflex Control of Posture and Movement*. Progress in Brain Research, 50. Elsevier/North-Holland Biomedical Press: Amsterdam, 795-803.
- Bizzi, E. and Polit, A. (1979) Characteristics of the motor programs underlying visually evoked movements. In: R.E. Talbott and D. Humphrey (Eds.), *Posture and Movement: Perspective for Integrating Sensory and Motor Research on the Mammalian Nervous System*. Raven Press: N.Y., 169-176.
- Bizzi, E., Dev, P., Morasso, P. and Polit, A. (1978) Role of neck proprioceptors during visually triggered head movements. In: J.E. Desmedt (Ed.), *Cerebral Motor Control in Man; Long Loop Mechanisms*. Progress in Clinical Neurophysiology, 4. S. Karger: Basel, 141-152.
- Bizzi, E. (1976) Coordination of movement. In: R.M. Herman, S. Grillner, P.S.G. Stein and D.G. Stuart (Eds.), *Neural Control of Locomotion*. Advances in Behavioral Biology, 18. Plenum Press: N.Y., 798-804.

Bizzi, E. (1975) Central control of eye and head movements in monkeys. In: G. Lennerstrand and P. Bach-y-Rita (Eds.), *Basic Mechanisms of Ocular Motility and Their Clinical Implications*. Pergamon Press: N.Y., 469-471.

Bizzi, E. (1975) Motor coordination: central and peripheral control during eye-head movement. In: M.S. Gazzaniga and C. Blakemore (Eds.), *Handbook of Psychobiology*. Academic Press: N.Y., 427-437.

Bizzi, E., Kalil, R.E. and Morasso, P. (1972) Central programming and peripheral feedback during eye-head coordination in monkeys. In: J. Dichgans and E. Bizzi (Eds.), *Cerebral Control of Eye Movements and Motion Perception*. S. Karger: Basel, 220-232.

ABSTRACTS

Dr. Bizzi has authored and co-authored hundreds of abstracts through the years, too numerous to list on this CV.