

## CURRICULUM VITAE

**Name/Position:** Jerome N. Sanes  
Professor of Neuroscience  
Department of Neuroscience  
Brown University

### Education:

- 1974 B. A. State University of New York at Binghamton, Department of Psychology
- 1977 M. A. University of Rochester, Department of Psychology, Neuroscience specialization.
- 1979 Ph. D. University of Rochester, Department of Psychology, Neuroscience specialization.

### Post-doctoral Training:

- 1979-1985 *Staff Fellow and Senior Staff Fellow*, Laboratory of Neurophysiology, National Institute of Mental Health.  
Mentor: Dr. Edward V. Evarts

### Professional and Academic Appointments:

- 1978-1979 Instructor. Department of Psychology, University of Rochester. Department of Psychology, St. John Fisher College, Rochester, New York (1978).
- 1985 Visiting Scientist. Department of Neurology, University of Düsseldorf, Düsseldorf, Germany.
- 1985-1989 Special Expert and Senior Staff Fellow, Human Motor Control Section, Medical Neurology Branch, National Institute of Neurological Disorders and Stroke, National Institutes of Health.
- 1991-1995 Scientific Director. Brown University Parkinson's Disease and Motor Disorders Unit. (Unit disbanded in 1995)
- 1997-2000 Director, Laboratory of Functional Neuroimaging, Foundation Santa Lucia, Rome, Italy.
- 1989-2000 Assistant (1989-93) and Associate (1993-2000) Professor (Research). Department of Neuroscience (1993-2000) and Center for Neural Science (1989-92), Brown University.
- 2001-2004 Associate Professor. Department of Neuroscience, Brown University.
- 2004-present Professor. Department of Neuroscience, Brown University.
- 2001-present Director. Brown University Magnetic Resonance Imaging Research Facility.
- 2004-2013 Co-Director. Graduate Program, Department of Neuroscience, Brown University.
- 2007-2008 Visiting Professor, Département d'études cognitives, École normale supérieure, Paris, France.
- 2015-2016 Visiting Scientist, Institute for Brain and Spinal Cord, Paris, France

## Completed Research and Scholarship

### Refereed Journal Articles

1. Sanes, J., P. J. Donovan and R. G. Burrig (1979) Consummatory behavior as a function of ambient temperature in septal-lesioned and control rats. *Journal of Neuroscience Research* 1:333-341.
2. Sanes, J. N. and J. R. Ison (1979) Conditioning auditory stimuli and the cutaneous eyeblink reflex in humans: Differential effects according to oligosynaptic or polysynaptic central pathways. *Electroencephalography and Clinical Neurophysiology* 47:546-555.
3. Sanes, J. N. and J. R. Ison (1980) A silent period in orbicularis oculi muscle of humans. *Journal of Neurology, Neurosurgery and Psychiatry* 43:504-509.
4. Gopinathan, G., H. Teräväinen, J. M. Dambrosia, C. D. Ward, J. N. Sanes, W. K. Stuart, E. V. Evarts and D. B. Calne, (1981) Lisuride in parkinsonism. *Neurology* 31: 371-376.
5. Morgan, N. T., J. N. Sanes, W. K. Stuart and W. S. Rasband (1981) A computerized system for determination of reaction time, movement time, and movement accuracy. *Electroencephalography and Clinical Neurophysiology* 51:563-566.
6. LeWitt, P. A., G. Gopinathan, C. D. Ward, J. N. Sanes, J. M. Dambrosia, R. Durso and D. B. Calne (1982) Lisuride versus bromocriptine in Parkinson's disease: A double blind study. *Neurology* 32:69-72.
7. Sanes, J. N., J. A. Foss and J. R. Ison (1982) Conditions that affect the thresholds of the components of the eyeblink reflex in humans. *Journal of Neurology, Neurosurgery and Psychiatry* 45:543-549.
8. Sanes, J. N. and E. V. Evarts (1983) Effects of perturbations on accuracy of arm movements. *Journal of Neuroscience* 3:977-986.
9. Sanes, J. N. and J. R. Ison (1983) Habituation and sensitization of components of the human eyeblink reflex. *Behavioral Neuroscience* 97: 833-866.
10. Sanes, J. N. and V. A. Jennings (1984) Centrally programmed patterns of muscle activity in voluntary motor behaviors of humans. *Experimental Brain Research* 54:23-32.
11. Sanes, J. N., K. -H. Mauritz, E. V. Evarts, M. C. Dalakas and A. Chu (1984) Motor deficits in patients with large-fiber sensory neuropathy. *Proceedings of the National Academy of Science* 81: 979-982.
12. Sanes, J. N. and E. V. Evarts (1984) Motor psychophysics. *Human Neurobiology* 2:217-225.
13. Sanes, J. N. (1984) Voluntary movement and excitability of cutaneous eyeblink reflexes. *Psychophysiology* 21:653-664.
14. Sanes, J. N. (1985) Information processing deficits in Parkinson's disease during movement. *Neuropsychologia* 23: 381-392.
15. Sanes, J. N. (1985) Absence of enhanced physiological tremor in patients without muscle or cutaneous afferents. *Journal of Neurology, Neurosurgery and Psychiatry* 48:645-649.
16. Sanes, J. N., K. -H. Mauritz, M. C. Dalakas and E. V. Evarts (1985) Motor control in humans with large-fiber sensory neuropathy. *Human Neurobiology* 4:101-114.
17. Sanes, J. N., T. R. Colburn and N. T. Morgan (1985) Behavioral motor evaluation for neurotoxicity screening. *Neurobehavioral Toxicology and Teratology* 4:329-337.
18. Sanes, J. N. (1986) Kinematics and end-point control of arm movements are modified by unexpected changes in viscous loading. *Journal of Neuroscience* 6:3120-3127.
19. Donoghue, J. P. and J. N. Sanes (1987) Peripheral nerve injury in developing rats reorganizes representation pattern in motor cortex. *Proceedings of the National Academy of Science* 84:1123-1126.

Refereed Journal Articles. [continued]

20. Pullman, S. L., R. L. Watts, J. L. Juncos, T. N. Chase and J. N. Sanes (1988) Dopaminergic effects on simple and choice reaction time performance in Parkinson's Disease. *Neurology* 38:249-254.
21. Sanes, J. N., S. Suner, J. A. Lando and J. P. Donoghue (1988) Rapid reorganization of adult rat motor cortex somatic representation patterns after motor nerve injury. *Proceedings of the National Academy of Science* 85:2003-2007.
22. Sanes, J. N., P. L. LeWitt and K. -H. Mauritz (1988) Visual and mechanical control of cerebellar kinetic postural tremor. *Journal of Neurology, Neurosurgery and Psychiatry* 51:934-943.
23. Donoghue, J. P. and J. N. Sanes (1988) Organization of adult motor cortex representation patterns following neonatal nerve injury in rats. *Journal of Neuroscience* 8:3221-3232.
24. Dimitrov, B., M. Hallett and J. N. Sanes (1989) Differential influence of posture and intentional movement on human somatosensory evoked potentials evoked by different stimuli. *Brain Research* 496:211-218.
25. Sanes, J. N., B. Dimitrov and M. Hallett (1990) Motor learning in patients with cerebellar dysfunction. *Brain* 113: 103-120.
26. Sanes, J. N., S. Suner and J. P. Donoghue (1990) Dynamic organization of primary motor cortex output to target muscles in adult rats. I. Long-term patterns of reorganization following motor or mixed peripheral nerve lesions. *Experimental Brain Research* 79:479-491.
27. Donoghue, J. P., S. Suner and J. N. Sanes (1990) Dynamic organization of primary motor cortex output to target muscles in adult rats. II. Rapid reorganization following motor nerve lesions. *Experimental Brain Research* 79:492-503.
28. Pullman, S. L., R. L. Watts, J. L. Juncos, and J. N. Sanes (1990) Movement amplitude choice reaction time performance in Parkinson's disease may be independent of dopaminergic status. *Journal of Neurology, Neurosurgery and Psychiatry*, 53:279-283.
29. Ison, J. R., J. N. Sanes, J. A. Foss, L. A. Pinckney (1990) Facilitation and inhibition of the human startle blink reflexes by stimulus anticipation. *Behavioral Neuroscience*, 104:418-429.
30. Sanes, J. N. and M. Hallett (1990) Limb positioning and magnitude of essential tremor and other pathological tremors. *Movement Disorders*, 5:304-309.
31. Cohen L. G., J. Meer, I. Tarkka, S. Bierner, D. Lederman, R. M. Dubinsky, J. N. Sanes, B. Jabbari, B. Branscum, and M. Hallett (1991) Congenital mirror movements: abnormal organization of motor pathways in two patients. *Brain*, 114:381-403.
32. Donoghue, J. P., S. J. Leibovic, and J. N. Sanes (1992) Organization of the forelimb area in squirrel monkey primary motor cortex: Representation of individual digit, wrist, and elbow muscles. *Experimental Brain Research*, 89:1-19.
33. Sanes, J. N., J. Wang, J. P. Donoghue (1992) Immediate and delayed changes of rat motor cortical output representation with new forelimb configurations. *Cerebral Cortex*, 2: 141-152.
34. Sanes, J. N. and J. P. Donoghue (1992) Organization and adaptability of muscle representations in primary motor cortex. *Experimental Brain Research, Supplement*, 22:103-127.
35. Agostino, R., M. Hallett and J. N. Sanes (1992) Antagonist muscle inhibition before rapid voluntary movements of the human wrist. *Electroencephalography and Clinical Neurophysiology*, 85:190-196.
36. Sanes, J. N. and J. P. Donoghue (1993) Oscillations in local field potentials of the primate motor cortex during voluntary movement. *Proceedings of the National Academy of Sciences (USA)*, 90:4470-4474.
37. Donoghue, J. P. and J. N. Sanes (1994) Motor areas of the cerebral cortex. *Journal of Clinical Neurophysiology*, 11:382-396.

Refereed Journal Articles. [continued]

38. Sanes, J. N. (1994) Neurophysiology of preparation, movement, and imagery. *Behavioral and Brain Sciences*, 17:221-223.
39. Labutta, R., R. B. Miles, J. N. Sanes, and M. Hallett (1994) Motor program memory storage in Parkinson's disease patients tested with a delayed response task. *Movement Disorders*, 9:218-222.
40. Sanes, J. N. and R. Shadmehr (1995) Sense of muscular effort in humans with large-fiber sensory neuropathy. *Canadian Journal of Physiology and Pharmacology*, 73:223-233.
41. Sanes, J. N., J. P. Donoghue, V. Thangaraj, R. R. Edelman and S. Warach (1995) Shared neural substrates controlling hand movements in human motor cortex. *Science*, 268:1775-1777.
42. Friedman, J. H. M. Epstein, J. N. Sanes, P. Lieberman, K. Cullen, C. Lindquist, M. Daamen (1996) Gamma knife pallidotomy in advanced Parkinson's disease. *Annals of Neurology*, 39:535-538.
43. Schlaug, G., J. N. Sanes, V. Thangaraj, D. G. Darby, L. Jäncke, R. R. Edelman, and S. Warach (1996) Cortical activation covaries with movement rate. *NeuroReport*, 7:879-883.
44. Agostino, R., Sanes, J. N., and Hallett, M. (1996) Movement skill learning in Parkinson's disease. *Journal of the Neurological Sciences*, 139:218-226.
45. Sanes, J. N. and J. P. Donoghue (1997) Dynamic motor cortical organization. *The Neuroscientist*, 3:158-165.
46. Donoghue J. P., J. N. Sanes, N. G. Hatsopoulos, and G. Gaál (1998) Neural discharge and local field potential oscillations in primate motor cortex during voluntary movements. *Journal of Neurophysiology*, 79:159-173.
47. Marzi, C. A., C. Miniussi, A. Maravita, L. Bertolasi, G. Zanette, J. C. Rothwell and J. N. Sanes (1998) Transcranial magnetic stimulation selectively impairs interhemispheric transfer of visuo-motor information in humans. *Experimental Brain Research*, 118:435-438.
48. Bhat, R. B. and J. N. Sanes (1998) Cognitive channels computing action distance and direction. *Journal of Neuroscience*, 18:7566-7580.
49. Maynard, E. M., N. G. Hatsopoulos, C. L. Ojakangas, B. D. Acuna, J. N., Sanes, R. A. Normann and J. P. Donoghue (1999) Neuronal interactions improve cortical population coding of movement direction. *Journal of Neuroscience*, 19:8083-8093.
50. Baker, J. T., J. P. Donoghue and J. N. Sanes (1999) Gaze direction modulates finger movement activation patterns in human cerebral cortex. *Journal of Neuroscience*, 19:10044-10052.
51. Sanes, J. N. and J. P. Donoghue (2000) Plasticity and primary motor cortex. *Annual Review of Neuroscience*. 23:393-415.
52. Sanes, J. N. (2000) Skill learning: Motor cortex rules for learning and memory. *Current Biology*, 10:R495-497.
53. Sanes J. N. (2000) The relation between human brain activity and hand movements. *NeuroImage*, 11:370-374.
54. Sanes J. N. and M. H. Schieber (2001) Orderly somatotopy in primary motor cortex: Does it exist? *NeuroImage*, 13:968-974.
55. Indovina I. and J. N. Sanes (2001) On somatotopic representation centers for finger movements in human primary motor cortex and supplementary motor area. *NeuroImage*, 13:1027-1034.
56. Galati, G., G. Committeri, J. N. Sanes and L. Pizzamiglio (2001) Spatial coding of visual and somatic sensory information in body-centered coordinates. *European Journal of Neuroscience*, 14:737-746.
57. Indovina I. and J. N. Sanes (2001) Combined visual attention and finger movement effects on human brain representations. *Experimental Brain Research*, 140:265-279.

Refereed Journal Articles. [continued]

58. Hagberg, G. E., G. Zito, F. Patria F, and J. N. Sanes JN (2001) Improved detection of event-related functional MRI signals using probability functions. *NeuroImage*, 14:1193-1205.
59. Eliassen, J. C., T. Souza and J. N. Sanes (2001) Human brain activation accompanying explicitly directed movement sequence learning. *Experimental Brain Research*, 141:269-280.
60. Acuna, B. D., J. N. Sanes, and J. P. Donoghue (2002) Cognitive mechanisms of transitive inference. *Experimental Brain Research* 146:1-10.
61. Hagberg, G. E., I. Indovina, J. N. Sanes, and S. Posse (2002) Real time quantification of T2\* changes using multi-echo planar imaging and numerical methods. *Magnetic Resonance in Medicine*, 48:877-882.
62. Acuna, B. D., J. C. Eliassen, J. N. Sanes, and J. P. Donoghue (2002) Frontal and parietal lobe activation during transitive inference in humans. *Cerebral Cortex* 12:1312-1321.
63. Sanes, J. N. (2003) Neocortical mechanisms in motor learning. *Current Opinion in Neurobiology*, 13:225-231.
64. Eliassen, J. C., T. Souza and J. N. Sanes (2003) Experience-dependent activation patterns in human brain during visual-motor associative learning. *Journal of Neuroscience*, 23:10540-10547.
65. Kim J. A., J. C. Eliassen, and J. N. Sanes (2005) Movement quantity and frequency coding in human motor areas. *Journal of Neurophysiology* 94:2504-2511. PMID: 15944229
66. Bédard, P., A. Thangavel, and J. N. Sanes (2008) Gaze influences finger movement-related and visual-related activation across the human brain. *Experimental Brain Research*, 188:63-75. PMID: PMC3065111
67. Thaut, M, M. Demartin, and J. N. Sanes (2008) Brain networks for integrative rhythm formation. *PLoS ONE*, 3:e2312. PMID: PMC2386151
68. Philip B. A., Y. Wu, J. P. Donoghue, J. N. Sanes (2008) Computational predictions of performance differences in visually- and internally-guided continuous manual tracking movements. *Experimental Brain Research* 190:475-491. PMID: PMC2574818
69. Bédard, P. and J. N. Sanes (2009) Gaze and hand position effects on finger-movement related human brain activation. *Journal of Neurophysiology*, 101:834-842. PMID: PMC2657059
70. Sheinkopf S. J., B. M. Lester, J. N. Sanes, J. C. Eliassen, E. R. Hutchison, R. Seifer, L. L. LaGasse, S. Durston, and B. J. Casey (2009) Functional MRI and response inhibition in children exposed to cocaine in utero: preliminary findings. *Developmental Neuroscience* 31:159–166. PMID: PMC2951722
71. Bédard P. and J. N. Sanes (2009) On a basal ganglia role in learning and rehearsing visual-motor associations, *NeuroImage*, 47:1701-1710. PMID: PMC3065103
72. Fiecas M., H. Ombao, C. Linkletter, W. Thompson, and J. N. Sanes (2010) Functional connectivity: shrinkage estimation and randomization test. *NeuroImage* 49:3005–3014. PMID: PMC3128923
73. Böhm H., H. Ombao, R. von Sachs, and J. N. Sanes (2010) Classification of multivariate non-stationary signals: the SLEX-shrinkage approach. *Journal of Statistical Planning and Inference*, 140:3754–3763.
74. Bédard P. and J. N. Sanes (2011) Basal ganglia-dependent processes in short-term recall of visual-motor skills. *Experimental Brain Research*, 209:385-393. PMID: PMC3065111
75. Bédard P., M. Wu, and J. N. Sanes (2011) Brain activation related to combinations of gaze position, visual input and goal-directed hand movements. *Cerebral Cortex*, 21:1273-1282. PMID: PMC3097986

Refereed Journal Articles. [continued]

76. Gorrostieta C., Ombao H., Bédard P. and J. N. Sanes (2012) Investigating brain connectivity using mixed effects vector autoregressive models. *Neuroimage*, 59:3347–3355. PMID: 22001164; PMCID: in progress.
77. Bédard P. and J. N. Sanes (2014) Brain representations of visual-motor adaptation learning and retention. *Neuroimage*, 101:225-235.

BIBLIOGRAPHY: PUBLICATIONS (REVIEW ARTICLES, COMMENTARIES, AND BOOK CHAPTERS)

1. Ward, C. D., J. N. Sanes, J. M. Dambrosia and D. B. Calne (1983) Methods for evaluating treatment in Parkinson's disease. In: *Advances in Neurology, Volume 37, Experimental Therapeutics of Movement Disorders*. Eds. S. Fahn, I. Shoulson and D. B. Calne. Raven Press, New York, pp. 1-7.
2. Sanes, J. N. and E. V. Evarts (1983) The regulatory role of proprioceptive input in motor control of phasic or maintained voluntary contractions in man. In: *Motor Control Mechanisms in Health and Disease*. Ed. J. E. Desmedt, Raven Press, New York, pp. 47-59
3. Sanes, J. N. and E. V. Evarts (1985) Psychomotor performance in Parkinson's disease. In: *Clinical Neurophysiology in Parkinsonism*. Eds. P. J. Delwaide and A. Agnoli, Elsevier Science Publishers B. V., Amsterdam, pp. 117-132.
4. Sanes, J. N. (1987) Neuromotor psychophysical aspects of central programming and peripheral regulation of movement in humans. In: *Advances in Applied Neurological Science, vol. 4. Clinical Aspects of Sensory Motor Integration*. Eds. A. Struppler and A. Weindl, Springer-Verlag, Berlin, 305-313.
5. Sanes, J. N. (1987) Proprioceptive afferent information and movement control. In: *Encyclopedia of Neuroscience*. Birkhäuser Boston Inc., Cambridge, Massachusetts, Volume II, 982-984.
6. Sanes, J. N. (1990) Motor representations in deafferented humans. A mechanism for disordered motor performance. In: *Attention and Performance XIII*. Ed. M. Jeannerod, Lawrence Erlbaum Associates, Hillsdale, NJ., pp. 714-735.
7. Sanes, J. N., R. Caminiti, J. P. Donoghue, G. W. Huntley, E. G. Jones, J. H. Martin, and M. H. Scheiber (1992) Representations in the primary motor cortex; Intrinsic circuitry of primate MI; Functional organization of MI arm area; Organization of muscle synergies in MI; MI and reaching; MI and skill learning. *Neuroscience Facts* 3(9) 1-4.
8. Donoghue, J. P., G. Hess and J. N. Sanes (1996) Motor cortical substrates and mechanisms for learning. *Acquisition of Motor Behavior in Vertebrates*, (ed.) J. R. Bloedel, T. J. Ebner, and S. P. Wise, MIT Press, Cambridge, pp. 363-386.
9. Sanes, J. N. and J. P. Donoghue (1997) Static and dynamic organization of motor cortex. *Advances in Neurology, vol. 73, Brain Plasticity*. H. -J. Freund, B. A. Sabel, O. W. Witte, eds. New York, Raven Press, 277-296.
10. Donoghue, J. P. and Sanes, J. N. (2000). Motor system organization. *Encyclopedia of Life Sciences*, <http://www.els.net>, London: Nature Publishing Group.
11. Sanes J. N. (2001) Primary motor cortex and primary somatic sensory cortex. In: *The Corsini Encyclopedia of Psychology and Behavioral Science, Third Edition*. Ed. W. E. Craighead and C. B. Nemeroff. John Wiley & Sons, New York, pp. 1243-1245.
12. Sanes, J. N. and W. Truccolo (2003) Motor “binding:” Do functional assemblies in primary motor cortex have a role? *Neuron* 38:3-5.

Review articles, etc. [continued]

13. Sanes, J. N. (2004) Primary motor cortex and primary somatic sensory cortex. In: *Concise Corsini Encyclopedia of Psychology and Behavioral Science*, Third Edition. Ed. W. E. Craighead and C. B. Nemeroff. John Wiley & Sons, New York, pp. 727-728.
14. Sanes, J. N. (2008) Cerebral Cortex: Motor Learning. In H.L. Roediger, III (Ed.), *Cognitive Psychology of Memory*. Vol. 3 of *Learning and Memory: A Comprehensive Reference*, 4 vols. (J. Byrne Editor). Oxford: Elsevier, pp. 423-440.
15. Sanes, J. N. (2008) Primary motor cortex and primary somatic sensory cortex. In: *Concise Corsini Encyclopedia of Psychology and Behavioral Science*, Fourth Edition. Ed. W. E. Craighead and I. Weiner. John Wiley & Sons, New York.
16. Sanes, J. N. (2017) Cerebral Cortex: Motor Learning. In H.L. Roediger, III (Ed.), *Cognitive Psychology of Memory*. *Learning and Memory: A Comprehensive Reference 2E*. (J. Byrne Editor). Oxford: Elsevier, pp. in press.

Book Reviews: None

Meeting Abstracts. (selected 2012-2017, from a total of >140 from 1975-present)

1. Sanes JN, Bédard P (2012) Parkinson's disease and brain representations for learning and recalling internal models. Abstract Viewer/Itinerary Planner. Washington, DC: Society for Neuroscience.
2. Sanes JN, Bédard P, Caminiti R, Chappidi MR, Battaglia-Mayer A (2013) Human brain representations of online adjustments of voluntary actions. 19 International Conference on Functional Mapping of the Human Brain, June 2013, Seattle, WA.
3. Bédard P, Sanes JN (2014) Brain activity during gradual visuomotor adaptation. Abstract Viewer/Itinerary Planner. Washington, DC: Society for Neuroscience.
4. Bédard P, Sanes JN (2015) Effective connectivity changes before and after sudden and gradual visual-motor adaptation. Abstract Viewer/Itinerary Planner. Chicago, IL: Society for Neuroscience.
5. Zhao Y, Luo X, Upfal E, Bédard P, Sanes JN (2016) Identification of "hot" local brain networks during motor sequence learning. Society for Neuroscience Abstract. San Diego, CA. 271.07.
6. Zhao Y, Luo X, Upfal E, Bédard P, Sanes JN (2017) Identification of "hot" brain subnetworks during motor learning. Annual meeting of the Organization of Human Brain Mapping, Vancouver, Canada, June 2017.
7. Garnaat S, Bédard P, Greenberg B, Sanes JN (2017) Brain activation during changes in action intention in obsessive-compulsive disorder. Annual meeting of the Organization of Human Brain Mapping, Vancouver, Canada, June 2017.
8. Bédard P, Garnaat SL, Greenberg BD, Sanes JN (2017) Obsessive-compulsive disorder and brain activation during changes in action intention. Annual meeting of the Society for Neuroscience, Washington DC, November 2017.

Invited lectures: International and National Meetings (total of 17)

1. Frontal motor cortical representation in primates: Implications for Learning and Rehabilitation. "Brain Plasticity." Satellite Symposium of Brain 95. Düsseldorf, Germany. July, 1995.
2. Motor cortical representations of bodily motion. "Workshops in Sensorimotor Control: Measuring body motion". Bangor, Wales, UK. April, 1996.

3. Organizing principles of human and monkey motor cortex. “Sensorimotor ‘96: Dynamics, Adaptation and Representation in Motor Cortex” Workshop preceding the Annual Meeting of the Society for Neuroscience, Washington, DC, November 1996.
4. Dynamic motor cortical representations. McDonnell-Pew Program in Cognitive Neuroscience Workshop, Oxford, England, June 1997.
5. Motor cortical organization in humans. International Congress on Clinical Neurophysiology. Brain Imaging Symposium. Florence, Italy, August 1997.
6. Patterns of human motor cortical organization. Congress of Physiology and Neuropharmacology of Rehabilitation. Rome, Italy, August 1997.
7. Dynamic movements in the human brain. Second Berlin Workshop on Cortical Plasticity. Berlin, Germany, April, 1998..
8. Activation patterns of human brain during voluntary motor actions. Workshop on “Epilepsy and Movement Disorders in Children”, IRCCS Stella Maris, INPE, Pisa, Italy, March 1998.
9. Functional magnetic resonance imaging of human brain during motor actions. European Clinical Neurophysiology Meeting, Ljubljana, Slovenia, June 1998.
10. Neural Information Processing. “McDonnell-Pew Program in Cognitive Neuroscience Workshop, Montreal, Canada, June 1998.
11. Patterns of cortical activation during cognitive and motor behavior. Eighth Congress on Neurological Rehabilitation. Milano, Italy, September, 1998
12. On the stability and modifiability of human cortical points revealed by functional magnetic resonance imaging. CNRS - Conference Jacques Monod : "Synaptic Plasticity, Assembly Dynamics and Flexibility of Cognitive Representations". Aussois (France). November 28–December 3, 1998.
13. Are there primitives for motor representations in the human brain? European Brain and Behavioral Society, 31st Annual Meeting. Rome, Italy. September, 1999.
14. Organization of the human brain revealed by functional MRI. First International Symposium on Cognitive Therapy, Perfetti Method. Staffelstein Clinic, Staffelstein, Bavaria, Germany, September 1999.
15. Short-term plasticity of human movement brain representations. Third Berlin Workshop on Cortical Plasticity. Berlin, Germany, March, 2000.
16. Conscious and unconscious action. Invited lecture. 7th Annual European Neurology Society, Paris, France, April 2001.
17. Cortical mechanisms of explicit and implicit learning. Invited Lecture. Satellite Symposium on Motor Learning, Neural Control of Movement. Annual Meeting, Barcelona, Spain, March 2004.

Papers Read: Invited Colloquia (Selected from Total of >80)

COLLOQUIA AT UNIVERSITIES AND RESEARCH INSTITUTIONS: (Selected from 1994-PRESENT)

Boston University; Harvard College; Johns Hopkins University; New York University; National Institutes of Health; University of Parma, Italy; Harvard Medical School; University of Roma, “La Sapienza”; University of Verona, Italy; Mount Sinai School of Medicine, NYC; University of Padova, Italy; Oxford University, Oxford, UK; Institute of Neurology and Wellcome Department of Cognitive Neurology, Queen Square, University College London; University of Düsseldorf, Düsseldorf, Germany; IRCCS Santa Lucia, Rome, Italy; Neurology Therapy Center, Düsseldorf, Germany; Brown University, Massachusetts Institute of Technology; Colorado State University; University of Minnesota; École normale supérieure, Paris, France; Radboud University of Nijmegen; École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland;



Department of Motor Neuroscience, University College London; INSERM, Unit 864, Lyon, France, IRCCS San Camillo, Venice, Italy; Neuroscience Institute, Alicante Spain.

#### Manuscripts under Editorial Review

1. Kim J. A., J. C. Eliassen and J. N. Sanes Brain activation for spatially and non-spatially cued visual motor arbitrary association learning. *NeuroImage*.

#### Manuscripts in Progress for Publication Submission

1. Kim J. A., J. C. Eliassen, M. B. Johnson, and J. N. Sanes. Spacing effect and variable inter-trial intervals have differential effects on rate of learning and level of acquisition in novel visual-motor arbitrary associations.
2. Eliassen J. C, M. B. Johnson, and J. N. Sanes. Stimulus- and feedback-related activation during associative motor learning.
3. Bédard P. and J. N. Sanes Brain representations of motor intention.
4. Luo X., X. Cheng, and J. N. Sanes Discriminant analysis application to detect brain network signals
5. Bédard P, Battaglia-Mayer A, Chappidi MR, Caminiti R, Sanes JN Human brain representations of on-line motor control.
6. Bédard P, Batty E, Sanes JN Movement-related tuning in human neocortex.

Books in Progress : Negotiating with Elsevier for a textbook “Neuroscience of Consciousness”

#### Research Awards

Current Grants: (as Principal Investigator)

2013-2018 National Institutes of Health, COBRE Center for Central Nervous System Function. IDeA P20GM103645, ~\$7,000,000 (Direct costs).

Current Grants: (as Co-Investigator)

2012-2017 US Veterans Administration, VA RR&D Service Center of Excellence, Center for Neurorestoration & Neurotechnology, RRDN9228C, Leigh Hochberg, Principal Investigator.

Current Grants: (as Trainer or Mentor)

2017-2018 National Institutes of Health, NIGMS, Advance-CTR Mentored Research Awards (internal review within Rhode Island).

2015-2018 National Science Foundation. Post-doctoral Fellowship Program. Changes-of mind in target selection for action. John McCarthy, Principal Investigator. Role: Co-Mentor

2014-2019 National Institutes of Health, *Interdisciplinary Predoctoral Neuroscience Training Program*. Diane Lipscombe, Principal Investigator.

2012-2017 National Institutes of Health, NINDS, *Neuroscience Advanced Predoctoral Training Grant*. Diane Lipscombe, Principal Investigator.

Completed Grants (as Principle Investigator)

- 2015-2016 BIBS Innovation Award, Identifying brain networks controlling movement planing and learning. Role: Co-Principal Investigator (with Eli Upfal and Xi Luo).
- 2014-2015 DEANS Award, Brown University, Alpert School of Medicine, \$80,000. Role: Co-Principal Investigator (with Benjamin Greenberg)
- 2014 Brown Institute for Brain Science, *Purchase of MR Spectroscopic Imaging Software and Hardware*, \$13,500.
- 2012 Brown Institute for Brain Science, *Establishment of a Non-invasive Brain Stimulation Facility*, \$400,000 (David Badre, Co-PI)
- 2009-2012 National Science Foundation, 0843938, *Motor Intention*, \$505,000.
- 2008-2013 National Institutes of Health, T32 NS062443, *Predocctoral Neuroscience Training*, \$875,000.
- 2006-2008 Department of Energy, *MRI System and Facility*, \$962,000.
- 2005-2009 National Institutes of Health, Research Grant, R01EY15451, *Visual Motor Integration*. \$750,000.
- 2002-2009 Falk Medical Research Trust, *Parkinson's disease, Alzheimer's disease and spinal cord injury*, \$1,000,000.
- 2002-2007 National Institutes of Health, Research Grant, R01 NS44834, *Cognition and Action*. \$830,000.
- 2005-2006 National Science Foundation, Major Research Infrastructure Grant, *Purchase of a 3T MRI system*, \$2,000,000.
- 2004-2006 DARPA (subcontract with VSM-Medical Systems. *MEG Brain Computer Interface*, ~\$340,000.
- 1997-2003 National Institutes of Health, Research Career Development Award, KO2 NS01978, *Functional brain organization*. \$250,000.
- 1996-1999 National Institutes of Health, Research Grant. *Functional brain organization*. ~\$448,600.
- 1997 National Institutes of Health, Shared Instrumentation Program, *Compute Cluster*, \$350,000.
- 1995-1998 McDonnell-Pew Program in Cognitive Neuroscience. Research Grant. *Neural Mechanisms of Preparation and Choice*, \$105,000.
- 1991-2003 National Institutes of Health, Research Grant, R01AG10634-01, *Neural control of human voluntary movements*, \$1,800,000.
- 1990-1995 Whitehall Foundation, Research Grant, *Cortical motor field neuronal network control of voluntary movements in monkeys*, \$180,000.
- 1990-1993 Charles E. Culpeper Foundation, Research Grant, *Motor cortical contributions to motor learning, adaptation, and attention*, \$157,600.

Completed Grants (as Co-Investigator)

- 2012-2013 National Institutes of Health, Shared Instrumentation Program, *Brain Science Compute Cluster*, \$600,000. John Donoghue, Principal Investigator.
- 2011-2016 National Institutes of Health, *HPA and Neural Response to Peer Rejection: Biomarkers of adolescent depression risk*, R01MH092450. Laura Stroud, Principal Investigator.

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- 2007-2017 National Eye Institute, NIH, *Predoctoral Visual Training Grant*. Michael Paradiso, Principal Investigator. [resubmission, May 2016, pending decision.
- 2005-2009 National Institutes of Health, Nicotine Dependence: Phenotype, Endophenotype and Contexts. ~\$7,600,000 total grant, ~\$62,000 for Co-I (Raymond Niaura, PI)

Pending Grants, (or to be submitted in upcoming grant cycle)

As Principal or Co-Principal Investigator

1. National Institutes of Health, *COBRE Center for Central Nervous System Function*. IDeA P20GM103645, \$7,500,000 (Direct costs)
2. National Institutes of Health, *Mechanisms of eye-hand coordination*. To be submitted, February 2018.
3. US Veterans Administration, MERIT award program. *Brain mechanisms of motor learning in Parkinson's disease*. To be submitted, June 2018.

As Co-Investigator or Mentor.

4. US Veterans Administration, VA RR&D Service Center of Excellence, Center for Neurorestoration & Neurotechnology, RRDN9228C, Leigh Hochberg, Principal Investigator. Term: 2018-2023. (submitted July 2017, received a 164 score [likely to-be-funded], site visit February 2018).
5. National Institutes of Health. Probing Neural Mechanisms of Behavioral Flexibility in OCD. Principal Investigator: Sarah Garnaat. Term: 2018-2020. (submitted November 2017)
6. National Institutes of Health. *Transgenerational impacts of maternal depression: Risk and protective effects of prenatal psychotropic medication exposures*. Principal Investigator: Amy Salisbury. Term: 2018-2023. (submitted December 2017)
7. National Institutes of Health. NIGMS COBRE *Center for Neurocircuits and Disease*. Principal Investigator: Benjamin Greenberg. Term: 2018-2023. (to be submitted January 2018)

**Service:**

To Brown University

Departmental and Program Activities

- Organizer of Motor Control Journal Club (1989-1994)
- Undergraduate Concentration Advisor, Neuroscience (1991-present).
- Chair, Neuroscience Graduate Program Seminar Series (1991-1997; 2001-2006)
- Organizer of Cognitive Neuroscience Journal Club (1994-1997)
- Graduate Student doctoral advisor (1995-present).
- Director, Brown University Magnetic Resonance Imaging Facility (2001-present)
- Co-Director, Neuroscience Graduate Program, Brown University (2004-2013)

Research Activities

- Supervision of undergraduate students in laboratory activities, some leading to Honors in Neuroscience (1989-present).
- Scientific Director: Brown University, Parkinson's Disease and Motor Disorders Unit. (1989-1994, unit disbanded in 1994)

Service: [continued]

Supervision of Post-doctoral and Medical Fellows: Jonathan H. Martin, M. D., Medical Fellow (1990-1992); James C. Eliassen, Ph. D. (1997-2003); Patrick Bédard, Ph. D. (2002-2008); Richard Archibald (2004-2005); Michael Kositsky (2005-2007); Ashvin Shah (2009-present).

Co-supervision of Post-doctoral Fellows: Gyöngyi Gaál (1992-1993); Nicholas Hatsopoulos, Ph. D., (1994-1996); Catherine Ojakangas, Ph. D., Post-doctoral Fellow (1994-1996).

Supervision of undergraduate students in laboratory activities, some leading to Honors in Neuroscience (1989-present).

#### University Committees

Sigma Xi Selection Committee (1995-1996)

Committee on Behavioral and Brain Science Curriculum (2001–2004)

Tenure, Promotion and Appointments Committee (Spring 2006, Fall 2008 – Spring 2011, Vice Chair: 2009-2010; Chair: 2010-2011)

Research Advisory Board (2013 - 2015)

Academic Priorities Committee (Academic years 2016-2019)

#### To the Scientific Community

Grant and Fellowship Proposal Review Panels. (1989—present)

##### National:

National Institutes of Health: Musculoskeletal and Dental Sciences, IFCN-5, BBB-3, IFCN-8, NCCR-Regional Resource; Program Project Special Emphasis Study Sections; Biomedical Engineering Research Partnerships, Ad-hoc member of Study Section, NINDS T32 Review Panel.

National Science Foundation (2005-2015)

Spinal Cord Research Foundation.

Veterans Administration.

New York Academy of Sciences, Blavatnik Young Investigator Award

##### International:

Pan-national: Human Frontiers Science Program

France: CNRS; French Ministry of Research, Integrative and Computational Neuroscience Program; National Research Agency

Israel: United States-Israel Binational Science Foundation

Italy: Ministry of Research, Science and Technology; Italian Space Agency.

Switzerland: Swiss National Science Foundation

United Kingdom: Wellcome Trust-United Kingdom Medical Research Council, Joint Infrastructure Program; Wellcome Trust Review Panel for Laboratory Funding Renewal.

#### Scientific Journals: Editorial Board Member.

*Neuroscience*, Associate Editor-in-Chief, 2016-present.

*Neuroscience*, Section Editor, Cognitive, Behavioral and Systems Neuroscience: 2006-2012; 2014-2016.

*Neuropharmacology*. Associate Editor, 2008-2016

*Experimental Brain Research*, Associate Editor, Neurophysiology Section: 1996–present.

*Journal of Neuroscience*, Associate Editor, Behavioral/Systems/Cognitive Section: 2005-2010.

*The Open Neuroimaging Journal*, Associate Editor: 2007-2011

Service: [continued]

*The Scientific World*, Associate Editor: 2007-2011.

*NeuroImage*: Associate Editor, 2000-2005.

Scientific Journals: Reviewer

Annals of Neurology, Behavioral Neuroscience, Brain, Canadian Journal of the Neurological Sciences, Cerebral Cortex, Current Biology, Electroencephalography and Clinical Neurophysiology, European Journal of Neuroscience, European Journal of Physiology, Experimental Brain Research, Experimental Neurology, Journal of Cerebral Blood Flow and Metabolism, Journal of Gerontology, Journal of Motor Behavior, Journal of Neurophysiology, Journal of Neuroscience, Journal of Psychiatric Research, Journal of the International Neuropsychological Society, Nature, Nature Neuroscience, Neuroimage, Neuron, Neuropsychologia, Neuroscience, Pediatrics, Perceptual and Motor Skills, Psychobiology, Psychological Bulletin, Psychophysiology, Science.

Scientific Society: Meeting Abstract Reviewer

Organization of Human Brain Mapping (2000-2006).

Instruction

Fidia International School of Neuroscience, Adjunct Faculty, 1991.

Functional Magnetic Resonance Imaging. Faculty. CNRS Course, Marseille, France. 1999.

To Other Universities

Thesis Committees:

Deborah Claman, Massachusetts Institute of Technology, 1984.

John Pelligrini, State University of New York at Stony Brook, 1993.

To Professional Societies.

Rhode Island Chapter of Society for Neuroscience: Organizer and President (1992-present)

Neuroscience Contact with National Society of Biology Teachers (1993)

Governmental and Public Affairs Committee, Society for Neuroscience (2014-present)

Professional Society Membership.

Society for Neuroscience

American Association for the Advancement of Science

Organization of Human Brain Mapping

**Honors and Awards.**

Academic Awards

1970-1974 New York State Regents Scholarship

1974-1977 United States Public Health Service Trainee

1974-1977 Rush Rhees Fellow, University of Rochester

1979 National Research Service Award

1995 Honorary Master of Arts, Brown University

2015-2016 Fulbright Scholar Award, Franco-American Commission

**Teaching and Mentoring** (1995-present: Note: Interrupted full-time employment at Brown October 1997 (on leave); resumed full-time employment January 2001; Role: Course Director unless otherwise noted)

Course Teaching

- 1995-1996 I. BN 195 : Independent Study (1 student)  
II. BN 192 : Systems and Cognitive Neuroscience (24 students)  
BN 196 : Independent Study (2 students)
- 1996-1997 I. BN 195 : Independent Study (2 students)  
II. BN 192 : Systems and Cognitive Neuroscience (23 students)  
BN 196 : Independent Study (1 student)  
EN 292 : Medical Image Analysis (Guest lecture)
- 2000-2001 I. Not present at University  
II. EN 250 : Medical Image Analysis (Guest lecture)
- 2001-2002 I. BN 293 : Functional MRI: Theory and Practice (13 students. ~10 auditors)  
BN 195 : Independent Study (2 students)  
GISP : Functional MRI (7 students)  
II. BN 193 : Topics in Neuroscience : Cognitive Neuroscience (8 students)  
BN 196 : Independent Study (1 student)
- 2002-2003 I. BN 105 : Cognitive Neuroscience (18 students)  
BN 195 : Independent Study (3 students)  
II. BN 196 : Independent Study (1 student)  
EN 250 : Medical Image Analysis (Guest lecture)
- 2002-2003 I. BN 105 : Cognitive Neuroscience (18 students)  
BN 195 : Independent Study (3 students)  
II. BN 196 : Independent Study (1 student)  
EN 250 : Medical Image Analysis (Guest lecture)
- 2003-2004 I. BN 105 : Cognitive Neuroscience (13 students)  
BN193 : Topics in Neuroscience, Motor Learning (6 students)  
BN 195 : Independent Study (1 student)  
II. BN 196 : Independent Study (1 student)
- 2004-2005 I. BN 105 : Cognitive Neuroscience (37 students)
- 2005-2006 I. BN205 : Advanced Systems Neuroscience (14 graduate students)  
II. BN206 : Advanced Cognitive Neuroscience (16 graduate students)
- 2006-2007 I. BN205 : Advanced Systems Neuroscience (12 graduate students)  
II. BN206 : Advanced Cognitive Neuroscience (10 graduate students)
- 2007-2008 Sabbatical Leave
- 2008-2009 II. NEUR2060 : Advanced Cognitive Neuroscience (14 graduate students)
- 2009-2010 I. NEUR2050 : Advanced Systems Neuroscience (15 graduate students)  
II. NEUR2940: Neural Correlates of Consciousness (6 students)
- 2010-2011 I. NEUR2050 : Advanced Systems Neuroscience (10 graduate students)

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- 2011-2012 I. NEUR2050 : Advanced Systems Neuroscience (12 graduate students)  
II. NEUR2060 : Advanced Systems Neuroscience (15 students); Guest Lecturer
- 2012-2013 II. NEUR2060 : Advanced Systems Neuroscience (14 students)
- 2013-2014 I. NEUR1930 : Neural Correlates of Consciousness (15 students)  
II. NEUR2060 : Advanced Systems Neuroscience (14 students)  
I. NEUR1970 : Independent Study (1 student)  
II. NEUR1970 : Independent Study (1 student)
- 2014-2015 II. NEUR2060 : Advanced Systems Neuroscience (10 students)
- 2015-2016 Sabbatical Leave
- 2016-2017 II. NEUR1940 : Neural Correlates of Consciousness (10 students)  
II. NEUR2060 : Advanced Systems Neuroscience (13 students)

Advising:

Undergraduates

- Concentration advising: > 80 students for Sc. B. in Neuroscience (1989-present)  
Undergraduate research projects supervised: >30 since 1989  
Undergraduate honors thesis (direct supervision or second reader): >15 since 1989

Graduates

- Graduate student advisory committees  
>20 since 1989 (at Brown and other Universities)  
Doctoral thesis committees  
>8 since 1989 (at Brown and other Universities)

Faculty

- Faculty Mentor: Joo-Hyun Song, Department of Cognitive, Linguistic and Psychological Sciences (2011-2016)