Special Topics: Sensory-motor Integration
Spring 2018

This Special Topics class will examine how the nervous system integrates sensory and motor signals to guide behavior. We will focus on how vision, audition and proprioception are used to guide movements of the eyes, arm and hand as well as the faculty of speech. Our knowledge of sensory-motor integration rests on a range of techniques including:

- neuropsychological studies of brain damaged patients.
- behavioral psychophysical studies that measure performance.
- electrophysiological and imaging studies that measure neural activity.
- stimulation and inactivation studies that manipulate neural activity.
- computational studies that model the computations performed by the brain.

In this class, you will learn to read and evaluate the primary literature that employs these techniques to investigate sensory-motor integration.

Course instructor:

Bijan Pesaran
bijan@nyu.edu
x8-3578
Meyer 1060

Class Time: Tuesday
12:10 – 1:55pm
Meyer 760

Office Hours: By appointment by email Friday afternoon between 2-4 pm. Meyer 1060.

Course Prerequisites: Behavioral and Integrative Neuroscience.

Course Structure:

There will be weekly reading assignments, drawn from peer-reviewed journals in the field of neuroscience. Each week two students will each prepare a paper for presentation from the readings that week. The students will each present their paper for ~30 min and both will then work together to prepare another 15-20 min synthesis comparing and contrasting the two papers. There will also be a written term paper at the end of the semester.

Presentations should:

- Introduce the problem the paper seeks to address in the larger context of sensory-motor integration.
- State the existing literature relevant to the problem.
- Present the methods and results of the paper.
- Analyze and discuss the significance of the findings

Your grade will be based on the class presentation, class participation, and quality of the term paper.

Class presentation: 25%
Class participation: 25%
Term paper: 50%

The term paper is due May 8th**.**

Term paper should:
- Identify a problem/question in the area sensory-motor integration.
- State the existing literature relevant to the problem.
- Present the methods and results of the paper.
- State and analyze the findings ie explain strengths and limitations
- Relate the analysis to the problem of interest.
- Length – 5 pages single spaced, 1" margins font size 11pt Arial. Not including refs or images.

Course Text: There is no course text but the book, "The Visual Brain in Action" by Milner and Goodale (Oxford University Press) will serve as a useful guide. The course is organized around readings of the primary literature and review articles

Course Syllabus

January 30: Organization meeting.

February 6: Disorders of space and movement (Alice, Mahdi)

Readings

Chapter 4 Milner and Goodale

Pisella L, Sergio L, Blangero A, Torchin H, Vighetto A, Rossetti Y. Optic ataxia and the function of the dorsal stream: contributions to perception and action. Neuropsychologia. 2009 Dec;47(14):3033-44.

Perenin MT, Vighetto A. Optic ataxia: a specific disruption in visuomotor mechanisms. I. Different aspects of the deficit in reaching for objects. Brain. 1988 Jun;111 (Pt 3):643-74.

Assignments:

Rondot P, de Recondo J, Dumas JL. Visuomotor ataxia. Brain. 1977 Jun;100(2):355-76. (Mahdi)

Ratcliff G, Davies-Jones GA. Defective visual localization in focal brain wounds. Brain. 1972;95(1):49-60. (Alice)

February 13: Saccades (Armaan, Raven)

Readings:

Sparks DL. Translation of sensory signals into commands for control of saccadic eye movements: role of primate superior colliculus. Physiol Rev. 1986 Jan;66(1):118-71.

Colby CL, Duhamel JR, Goldberg ME. Oculocentric spatial representation in parietal cortex. Cereb Cortex. 1995 Sep-Oct;5(5):470-81. Review. PubMed PMID: 8547793.

Assignment:

Jay MF, Sparks DL. Sensorimotor integration in the primate superior colliculus. I. Motor convergence. J Neurophysiol. 1987 Jan;57(1):22-34. (Armaan)

Duhamel JR, Colby CL, Goldberg ME. The updating of the representation of visual space in parietal cortex by intended eye movements. Science. 1992 Jan 3;255(5040):90-2. PubMed PMID: 1553535. (Raven)

February 20: Reaching I (Mahdi, Sacha)
Mohammad Khazali

Readings:

Soechting JF, Flanders M. Moving in three-dimensional space: frames of reference, vectors, and coordinate systems. Annu Rev Neurosci. 1992;15:167-91. Review. PubMed PMID: 1575441.

Crawford JD, Henriques DY, Medendorp WP. Three-dimensional transformations for goal-directed action. Annu Rev Neurosci. 2011;34:309-31.

Assignments:

Batista AP, Buneo CA, Snyder LH, Andersen RA. Reach plans in eye-centered coordinates. Science. 1999 Jul 9;285(5425):257-60. (Mahdi)

Beurze SM, Toni I, Pisella L, Medendorp WP. Reference frames for reach planning in human parietofrontal cortex. J Neurophysiol. 2010 Sep;104(3):1736-45. (Sacha)

February 27: Reaching II (Paulomi, Wentao)

Reading:

Makin TR, Holmes NP, Ehrsson HH. On the other hand: dummy hands and peripersonal space. Behav Brain Res. 2008 Aug 5;191(1):1-10.

Assignments:

Graziano MSA. Where is my arm? The relative role of vision and proprioception in the neuronal representation of limb position. Proc Natl Acad Sci USA. 1999 Aug 31;96(18):10418-10421. (Paulomi)

Sekiyama K, Miyauchi S, Imaruoka T, Egusa H, Tashiro T. Body image as a visuomotor transformation device revealed in adaptation to reversed vision. Nature. 2000 Sep 21;407(6802):374-7. (Wentao)

March 6: Rescheduled due to conflicts.

March 13: Spring break. No class.

****ALTERNATE DAY****
March 23: Grasping I (Armaan, Tej)
2:30-4:30pm FRIDAY

Readings:

Schieber MH, Santello M. Hand function: peripheral and central constraints on performance. J Appl Physiol. 2004 Jun;96(6):2293-300.

Jeannerod M. Mechanisms of visuomotor coordination: a study in normal and brain-damaged subjects. Neuropsychologia. 1986;24(1):41-78. Review. PubMed PMID: 3517680.

Assignments:

Jakobson LS, Archibald YM, Carey DP, Goodale MA. A kinematic analysis of reaching and grasping movements in a patient recovering from optic ataxia. Neuropsychologia. 1991;29(8):803-9. (Armaan)

Santello M, Flanders M, Soechting JF. Postural hand synergies for tool use. J Neurosci. 1998 Dec 1;18(23):10105-15. (Tej)

Supplementary:

Goodale MA, Milner AD, Jakobson LS, Carey DP. A neurological dissociation between perceiving objects and grasping them. Nature. 1991 Jan 10;349(6305):154-6.

March 27
Grasping II (Alice, Raven, Sacha make-up)

Readings:

Castiello U. The neuroscience of grasping. Nat Rev Neurosci. 2005 Sep;6(9):726-36.

Jeannerod M, Arbib MA, Rizzolatti G, Sakata H. Grasping objects: the cortical mechanisms of visuomotor transformation. Trends Neurosci. 1995 Jul;18(7):314-20.

Assignments:

Rizzolatti G, Camarda R, Fogassi L, Gentilucci M, Luppino G, Matelli M. Functional organization of inferior area 6 in the macaque monkey. II. Area F5 and the control of distal movements. Exp Brain Res. 1988;71(3):491-507. (Raven)

Murata A, Gallese V, Kaseda M, Sakata H. Parietal neurons related to memory-guided hand manipulation. J Neurophysiol. 1996 May;75(5):2180-6.

Murata A, Gallese V, Luppino G, Kaseda M, Sakata H. Selectivity for the shape, size, and orientation of objects for grasping in neurons of monkey parietal area AIP. J Neurophysiol. 2000 May;83(5):2580-601. (Alice)

****ALTERNATE DAY****
April 6: Term paper class discussion
2:30-4:30pm FRIDAY

Each student will present the proposed topic of the term paper to the class and identify and discuss the selected literature they will analyze.
The class will discuss for 10 minutes, per topic.

April 10: Eye-hand coordination (Wentao, Tej)
Mohammad Khazali

Readings:

Land MF. Vision, eye movements, and natural behavior. Vis Neurosci. 2009 Jan-Feb;26(1):51-62.

Jeannerod M. Mechanisms of visuomotor coordination: a study in normal and brain-damaged subjects. Neuropsychologia. 1986;24(1):41-78. Review. PubMed PMID: 3517680.

Johansson RS, Westling G, Bäckström A, Flanagan JR. Eye-hand coordination in object manipulation. J Neurosci. 2001 Sep 1;21(17):6917-32.

Assignments:

Rotman G, Troje NF, Johansson RS, Flanagan JR. Eye movements when observing predictable and unpredictable actions. J Neurophysiol. 2006 Sep;96(3):1358-69. (Wentao)

Sailer U, Flanagan JR, Johansson RS. Eye-hand coordination during learning of a novel visuomotor task. J Neurosci. 2005 Sep 28;25(39):8833-42. (Tej)

Supplementary:

Biguer B, Jeannerod M, Prablanc C. The coordination of eye, head, and arm movements during reaching at a single visual target. Exp Brain Res. 1982;46(2):301-4.

April 17: Internal models (Michael, Sacha, Armaan make-up)

Reading:

Wolpert DM, Ghahramani Z. Computational principles of movement neuroscience. Nat Neurosci. 2000 Nov;3 Suppl:1212-7.

Assignments:

Blakemore SJ, Goodbody SJ, Wolpert DM. Predicting the consequences of our own actions: the role of sensorimotor context estimation. J Neurosci. 1998 Sep 15;18(18):7511-8. (Sacha)

Eliades SJ, Wang X. Sensory-motor interaction in the primate auditory cortex during self-initiated vocalizations. J Neurophysiol. 2003 Apr;89(4):2194-207. (Michael)

Supplementary:

Eliades SJ, Wang X. Neural substrates of vocalization feedback monitoring in primate auditory cortex. Nature. 2008 Jun 19;453(7198):1102-6.

April 24: Neural prostheses and degeneration - Rough outline/draft of term paper due. (Michael, Sai)

Readings:

Hatsopoulos NG, Donoghue JP. The science of neural interface systems. Annu Rev Neurosci. 2009;32:249-66.

Rossi PJ, Gunduz A, Judy J, Wilson L, Machado A, Giordano JJ, Elias WJ, Rossi MA, Butson CL, Fox MD, McIntyre CC, Pouratian N, Swann NC, de Hemptinne C, Gross RE, Chizeck HJ, Tagliati M, Lozano AM, Goodman W, Langevin JP, Alterman RL, Akbar U, Gerhardt GA, Grill WM, Hallett M, Herrington T, Herron J, van Horne C, Kopell BH, Lang AE, Lungu C, Martinez-Ramirez D, Mogilner AY, Molina R, Opri E, Otto KJ, Oweiss KG, Pathak Y, Shukla A, Shute J, Sheth SA, Shih LC, Steinke GK, Tröster AI, Vanegas N, Zaghloul KA, Cendejas-Zaragoza L, Verhagen L, Foote KD, Okun MS. Proceedings of the Third Annual Deep Brain Stimulation Think Tank: A Review of Emerging Issues and Technologies. Front Neurosci. 2016 Apr 6;10:119. doi:10.3389/fnins.2016.00119. eCollection 2016.

Assignments:

Hwang EJ, Bailey PM, Andersen RA. Volitional control of neural activity relies on the natural motor repertoire. Curr Biol. 2013 Mar 4;23(5):353-61. (Michael)

Zimnik AJ, Nora GJ, Desmurget M, Turner RS. Movement-related discharge in the macaque globus pallidus during high-frequency stimulation of the subthalamic nucleus. J Neurosci. 2015 Mar 4;35(9):3978-89. (Sai)

May 1: Speech (Sai, Paulomi)

Readings:

Hickok G, Houde J, Rong F. Sensorimotor integration in speech processing: computational basis and neural organization. Neuron. 2011 Feb 10;69(3):407-22.

Assignments:

Hickok G, Okada K, Serences JT. Area Spt in the human planum temporale supports sensory-motor integration for speech processing. J Neurophysiol. 2009 May;101(5):2725-32. Epub 2009 Feb 18. PubMed PMID: 19225172. (Sai)

Nasir SM, Ostry DJ. Somatosensory precision in speech production. Curr Biol. 2006 Oct 10;16(19):1918-23. (Paulomi)

Tremblay S, Shiller DM, Ostry DJ. Somatosensory basis of speech production. Nature. 2003 Jun 19;423(6942):866-9. PubMed PMID: 12815431. (Paulomi)

May 8: Term papers Due - Class debate

Question: “Do insects share neural mechanisms of sensory-motor integration with humans”

Huston SJ, Jayaraman V. Studying sensorimotor integration in insects. Curr Opin Neurobiol. 2011 Jun 24.

Wehner R, Menzel R. Do insects have cognitive maps? Annu Rev Neurosci. 1990;13:403-14. Review. PubMed PMID: 2183682.