סילבוס מפורט

שם הקורס

מבוא למערכות סנסוריות (עיבוד במערכת החושים)

מרצה

מארק שיין-אידלסון, פבלו בלינדר, ענן מורן, משה פרנס, יוסי יובל

סמסטר

ב

דרישות הקדם הקורס

אחד מקורסי המבוא הבאים או קורס מקביל בנוירוביולוגיה: מבוא לנוירוביולוגיה (0455-2237), נוירוביולוגיה 1 (0104-1408), נוירוביולוגיה (1500-2000).

הרכב הציון הסופי

מבחן (100%)

מבנה הקורס

תאריך / מס' שיעור	נושא השיעור ותכני השיעור (מטלות, רשימת קריאה, משימות וכיו"ב)
1	**Introduction to sensory systems design** Philosophical background on sensation (materialism, transcendal idealism and functionalism), review of sensory transduction (beyond the 5 senses), general principles of sensory transduction (cranial nerves, thalamus, pathways to cortex, labelled lines, topographic mapping, The evolution of sensory transducers, convergence divergence, transduction to ion currents and potentials, rate codes, adaptation, receptive field, center-surround, recurrent circuits and active sensing), psychophysics and the Fechner-Weber law, evolution of sensory transduction. **Vision – the eye and the retina** Structure of the eye, photo receptors, night and day vision, spatial resolution and acuity, color vision, light adaptation, the molecular biology of photo transduction and cascades (Wald), signal amplification, patch clamp (methods), dark current and graded potentials, pigment epithelium, recycling, ribbon synapses, temporal resolution, quantal sensitivity of the retina.
2	**Vision – circuits of the retina 1 + methods** Methods – seeing the retina (Goldi, antibodies, single cell fills, fluorescent proteins and genetic manipulations, serial section electron microscopy), and measuring its activity (Ca imaging, MEA,CMOS-MEA), layers of the retina, Receptive fields (Hartline), center surround (Kuffler), on-off cells, bipolar cells (structural, genetic and functional cell types), the photoreceptor-bipolar synapse, molecular pathways in on-off transduction, filtering properties, bipolar output synapse, evolution and diversity of

bipolar cells across vertebrates.	
Vision – circuits of the retina 2 Inhibitory circuits of the retina, horizontal cells, amacrine cells & their diversity, direction selectivity in the retina (mechanisms and types of direction selective ganglion cells and amarcine cells), alpha/beta/gamma ganglion cells, mosaic organization in the retina, receptive field mapping, color opponency and mosaics, how many cell types in the retina (genetic / morphological / physiological classification)? ipRGCs, evolution of the eye (evolution of retinal cirucits, spatial organization, photoreceptors)	3
Vision – First stations in the brain Circuits for pupil constriction and accommodation, superior colliculus (structural organization, connectivity and function), structural and functional organization of the dorso-lateral geniculate, dLGN cell types, convergence and divergence in thalamus, thalamic relay and beyond, the primary visual cortex, organization in layers and the canonical circuit, cell types in V1, retinotopic mapping across species, orientation and direction tuning (Hubel&Wiesel), hierarchical models and others, tangential organization and cortical columns (orientation, ocular, frequency, color), optimized classifications in V1, plasticity in unimodal and cross modal representation.	4
Vision – extrastriate cortex and the ventral pathway Methods (widefield Ca imaging, serial 2P tomography, neuropixels, fMRI), the classical and the shallow hierarchical models, receptive fields in high visual areas, V2 representations, disparity and border ownership, V3, the ventral pathway, V4 representations, color perception, inferior temporal cortex and invariance groups, deep learning networks and optimal feature tuning, categorical perception, face and object representation, learning associations, perceptual constancy and optical illusions, dorsal pathway and the memory system grandmother cells.	5
Vision – the dorsal pathway, eye movements and active sensing Areas MT, motion tuning and motion illusions, parietal and frontal cortex interactions in visio-motor transformations (MIP, VIP, AIP, PMd, PMv), active sensing, types of eye movements and their control, methods (oculometery), vestibulo-ocular reflex, gaze shifts (vergence, persuit and saccades), change blindness, saccades and cognitive processes, fixational eye movements (saccades, microsaccades & drift), optical illusions, saccadic suppression, lateral intraparietal area and visual saliency maps, spatial compression, predictive remapping and the supporting efferent copy circuits, Sherrington vs von Helmholtz, predictive coding.	6
Vision – sensory processing in behaving animals (motion signals in sensory areas) and summary (2 hours) Motor representation across sensory areas and perspectives in sensory	7

motor integration. **Somatosensation (1 hour)** Mechano-recptors, nociceptors, heat receptors, the whisker system, follicle biophysics, lemniscal pathways, trigeminal circuits.	
Somatosensation Somatosensation circuits and processing in the thalamus, the barrel cortex, canonical circuits across layers, cortical state and somatosensation, loops in the somatosensory system, exploratory whiskey behaviour active sensing, oscillations and coordination by rhythms, motor planning.	8
Olfaction Structure of the nose, olfactory receptors, receptor genes, odour transduction, circuits and organization of the olfactory bulb, structure and function of the olfactory cortex, convergence divergence in the olfactory pathway, sparse coding of odours, the accessory olfactory system, the olfactory system of insects and comparative insights.	9
Taste Tastes, taste receptors, taste buds and taste cells, distribution of taste cells in the mouth, anatomical pathways from the taste cells to and within the CNS, labelled lines and across fibres models of taste information processing, firing rate coding and temporal/dynamic coding in the taste system, internal states and taste coding.	10-11
Audition The structure and physics of sound, fourier and spectrograms, human hearing thresholds, structure of the ear, the outer ear and middle ear, the cochlea, organization of hair cells, auditory transduction and strain activated channels, frequency representations in cochlea, adaptation, amplification in outer hair cells, ribbon synapses, spiral ganglion (coding and structure), frequency tuning, evolution of the ear, cochlear implants, sound localization, superior olive and inferior colliculus, organization and processing in the auditory cortex.	12
Echolocation Fundamental of echolocation (e.g. the radar equation), degrees of freedom in echolocation (signal design, sampling rate, gain control), guilds of echolocation (how echolocation fits the habitat), neuroethology of echolocation	13

קריאת חובה

Kandel, Principles of Neural Science (5th edition).

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קריאת רשות

Squire, L. R. Fundamental neuroscience. (Elsevier/Academic Press, 2013).
Mountcastle, V. B. The sensory hand: neural mechanisms of somatic sensation. (Harvard University Press, 2005).
Reilly, S. & Schachtman, T. R. Conditioned taste aversion: behavioral and neural processes. (Oxford University Press, 2009).
Chalupa, L. M. & Werner, J. S. The visual neurosciences. (MIT Press, 2004).
Werner, J. S. & Chalupa, L. M. The new visual neurosciences.
Schnupp, J., Nelken, I. & King, A. Auditory neuroscience: making sense of sound. (MIT Press, 2011).

הערות

מומלץ לקחת את הקורס "מבוא למערכות סנסוריות" במקביל לקורס "סדנה חישובית במערכות סנסוריות".
בסדנה ננתח סיגלים ממערכות חושים של בעלי חיים ונראה כיצד העקרונות שלמדנו מיושמים בתבניות הירי של אוכלוסיות נוירונים.