FAV - Lectures and Outlines

http://nemo.lf1.cuni.cz/mlab/ftp/PPT-CVUT/

Outline 3

- Auditory nerve encodes sound in digital format – using trains of action potentials (spike trains) composed from binary (all-or-none) pulses.
- Auditory pathway branches into two anatomically and functionally distinct neural pathways: 1 ascending mono-aural pathway and 2 binaural pathway.
- Between cochlea and auditory cortex, signal is relayed through circa 10 neuronal relays (we highlight 7 here). Not all of them have known functions.
- This (3rd) talk deals with sub-cortical processing, while next (4th) deals with thalamo- cortical, in short cortical processing.
- Distinct mono aural nuclei are: 1 spiral ganglion (auditory nerve center), 2_cochlear nuclei, 3 superior olivary complex and 4 lamina quadri-gemina nuclei, one of whose is inferior colliculus. Then as numbers 5, 5A, 5B, 5C the pathway is intertwinned through the bundle of lemniscus lateralis to 6 medial geniculate nucleus, which is in fact thalamic nucleus.
- Last stage is 7 auditory part of cerebral cortex consisting od several auditory areas, one called primary and the rest is dubbed secondary.
- Binaural pathway starts with the 3rd neuron of medial or lateral superior olive.
- While it is easy to dissect these pathways into anatomical parts, it is relevant what are functions of these, and they are mostly unknown to date.
- Majority of this talk deals with spikes, so let us start over with the spikes = action potentials.

Outline 4

- Thalamus is a gateway through which sensory stimulation gains attention and processing. We can be woken up by strong auditory or visual stimuli
- Neocortical brain areas have common features (six layers) and distinctions (sensory versus motor, and others)
- There are circa 50 distinct (Brodmann) areas
- Sensory areas are typically divided into ‘primary’ and ‘secondary’, but the functional features of processing order between these remain unclear
- Distinct areas enable vocalization: speech centers
- Inter-hemispheric division of labor: when we sing a song, left (dominant) hemisphere maintains lyrics and the other hemisphere contains the melody
- Speech sounds (vowels, consonants) have distinct spectral and temporal features (formants).
- There are critical developmental periods for speech acquisition – language understanding starts before speech production. Developmental period partly closes in puberty.
- Language families
- Hearing loss in ageing progresses across modalities and higher loudness often does not help – is there a need for augmented media??

“Binary Trees of Brodmann Areas” and beyond Brodmann areas

- Bit 1: (Left) vs. (Right) Hemisphere
- Bit 2 and 3: (Motor/ Frontal Lobe) (Somatosensory/ Parietal L.)
- Bit 2 and 3: (Auditory/ Temporal L.) (Visual/ Occipital L.)
- Bit 4: (Primary) vs. (Secondary) Sensory projection areas
- Bit 5 6 7: subdivisions of visual areas
- Sensory Domains: Bit 1 8: (Left/ Right) vs. (Bottom/ Top) extention, retinotopy, spatial map
- Bit 9: Temporal encodings: subcortical
- Bit 10: Other modality encodings – Hippocampus (Archi-cortex)/ space navigation, and so on.

Olfactory cortex (Archi-cortex), Vestibular system, Remaining senses: Olfaction, Smell and Touch

Outline 8 – Subcortical Visual Pathway

- Retina, Point Spreading Function
- Adaptation, Acomodation
- Visual Acuity, Optical Eye Media, Lens
- Rods, Cones, Illumination, Black and White and Color Vision
- Color Opponent System in the Visual Pathway
- Binocular Vision and Its Disorders, Vergence, Strabism
- Saccades, Visual Following, Nystagmus
- Visuomotor Eye Movement Control, Basic Concepts
- Ten Neural Layers in Retina, Functional Aspects
- Optical nerve, Perimeter, Objective Perimeter

Outline 9 – Visual Cortex

- Primary and Secondary Visual Areas
- Synthetic Overview: Image Processing, Receptive Fields, Physiological ‘Laws’
- Not All Visual Areas Contain Consciously Accessible Representation – Eye Rivalry
- Magnocellular and Parvocellular Pathways
- V1, V2, V3, MT and other areas
- Modalities of Vision Based on Cortical Processing
- Features not Residing in Unique Areas: Stereo Disparity, Color
- Features Located To areas: Dorsal (Location and Motion) versus Ventral (Object) Streams
- Controversies
- Processing Hierarchy of the Visual Cortex

Outline 10 – Visual and auditory interactions

- Sound localization
- Visual object localization
- Neocortical brain areas have common features (six layers) and distinctions (sensory versus motor, and others)
- Sensory areas are typically divided into ‘primary’ and ‘secondary’, but the functional features of processing order between these remain unclear
- There are circa 50 distinct Brodmann areas
- Unity of a sensory object in space.
- Attentional focusing of spatially and temporally distinct parts of stimuli
- Conflicting Auditory and Visual Stimuli, Example: Ventriloquism
- Ego centered coordinates, Head centered coordinates, Head and eye movements
- Correspondence to the Vestibular system
- Locomotion and auditory and visual perception

Outline 11 – Vision Disorders, Visual Illusions, Visual Prostheses

- Common Retinal and Cortical Disorders
- On Types of Glasses We Wear
- Color Blindness, Night Blindness (Vitamin A Deficiency) and Presbyopia
- Illusions, Hallucinations, Pseudo-hallucinations
- Classification of Illusions
- Rare Neuro-Visual Disorders Let Us Get Insights Into Central Visual Processing, Some Are Caused by Carbon Monoxide Poisoning
- Split Brain, Hemi-Neglect and Other Cognitive deficits
- Illumination Hygiene, Age Related Macular Degeneration and Retinitis Pigmentosa
- Hearing vs. Visual Prostheses, Cochlear Implants
- Augmented Images, Augmented Sound

Thanks for your attention

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END
OF THE LECTURE

Outline X –

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- X