Cognitive Neuroscience Mids

Unsolved Mysteries Slide:

- Consciousness
    - Vegetative State
- Perception

Introduction Slide 1,2

- Cognition
- Cognition, Evolution link
- Phrenology
- Parts of brain [FTPO]
- Neuron structure
- Logical equivalent of Neuron

Anatomy of Brain

- Homunculus
- Sensory Cortex & Motor Cortex
- Types of neurons
- Electrical Synapse (dendrite-dendrite)
- Chemical Synapse (dendrite-axon)
    - Propagation of action potential
- Stages of action potential:
    - Depolarization
    - Repolarization
    - Hyperpolarization
- Neurotransmitters
    - Inhibitory (Serotonin, Gaba, Dopamine)
    - Excitatory (Dopamine, Norepinephrine, Epinephrine, Glutamate)
- **Multiple Sclerosis** - Demyelination

- **Focal Epilepsy** - Effects of misfiring
- **Seizure** - Too much excitation (*inward* Na^+ Ca^{++}), too little inhibition (*outward* Cl^-, K^+)
- **Sleep Deprivation** (glymphatic system that removes waste is much more active during sleep)
- Electroencephalogram (EEG)
    - Logic
    - Issues (*amplification req, deep parts not well sampled, not easy to isolate specific points in brain*)
    - Presynaptic action potential (1ms) not measurable by EEG, Postsynaptic action potential (10ms) is measurable.
    - 10-20 System of electrode placement (21 electrodes)
        - Odd over left, even over right
    - ERP
        - Qualitative info (*polarity, topology*)
        - Quantitative info (*latency, amplitude*)
    - N400, P600 for language
    - Issues and Disadvantages:
        - Does not reveal cause of cortical dysfunction
        - Low sensitivity
        - Low specificity
        - Influenced by alertness, drugs etc.
        - Small or deep lesions not detected
        - Limited time sampling
    - Strengths and Advantages:
        - Useful measure, supplements neuroimaging
        - Provides direct evidence
        - Provides some spatial localisation
        - Low cost
        - Low morbidity
        - Repeatable
        - Portable
    - Use in Management of Seizure:

- Support clinical diagnosis
- Classification
- Help localization
- Quantification
- Decision on AED treatment

Visual Systems

- Color, shape, depth, motion, texture
- **Blindness**:
  - Normal : eye dysfunction
  - Cortical : brain dysfunction
- Eye : parts
- View: monocular - 160x135, binocular - 200x135
- Visual Grasp Reflex
- Retina structure
  - Ganglion axons
  - Ganglion cell layer -- action potential
  - Bipolar cell layer -- graded potential
  - Receptor layer -- graded potential
  - Pigmented Epithelium
- Cones - *Color : hue, saturation, brightness*
- Rods - *shapes*
- Intensity of light causes changes in neurotransmitter release, which in turn affects the action potential
- Retinal Ganglion -- Edge detection
- Pathways for vision :
  - What -- to temporal
  - Where -- to parietal
  - Convergence on frontal cortex
  - Feature based, motion detected differently
- **Visual Agnosia:**
  - **Apperceptive** : Unable to identify features

    - **Associative :** Unable to extract meaning
    - Caused by damage to temporal lobe, ‘what’ pathway disruption
- **Prosopagnosia**
    - Unable to recognise faces
- **Color Deficiency:**
    - **Deuteranomaly :** Green, most common
    - **Protanopia :** Red
    - **Tritanopia :** Blue
- Lateral Geniculate Nucleus (LGN)
    - 4 Parvo cell layers -- input from midget ganglion cells
    - 2 Magno cell layers -- input from parasol ganglion cells
    - Makes it easy for cortex to combine inputs from both eyes
    - Feedback inputs (90%) from brain stem help with attention
    - Parvo cells:
        - Majority (80-90%)
        - Small receptive field
        - Slow conduction rate
        - Low contrast sensitivity
        - Able to differentiate detailed stimuli
        - Color sensitive
        - Deals with color and detail
    - Magno cells:
        - Exact opposite of all points above
- Visual Cortex
    - V1 processes input from LGN passes to others.
    - Hubel and Wiesel
    - V1:
        - 3 different neurons :
            - Simple
            - Complex
            - Hypercomplex
        - Transform information, being orientation and direction selective

        - Respond best to up-right motion
        - Simple Cell Functions:
            - Respond best to elongated bars, edges
            - Orientation Selective
            - Can be monocular, binocular
            - Have ON, OFF subregions -- spatially inhomogeneous
            - Perform length summation
        - Complex Cell Functions:
            - Orientation Selective
            - Spatially homogeneous
            - All binocular
            - Perform length summation
        - Hypercomplex Cell Functions:
            - Same as complex except for inhibitory flanks on end of receptive field
- Alan Burgess
    - **Hemispatial Neglect :** inability to pay attention to sensory stimuli on left side
    - Stroke damage to parietal lobe on right -- deals with higher aspects of attention

Visual Agnosia

- Apperceptive and Associative
- Damage to 'where' pathway - occipitotemporal
- Alan Burgess
- Ventral stream leisons:
    - **Object Agnosia**
    - **Prosopagnosia**
- Dorsal stream defects:
    - **Balint's Syndrome**
        - **Simultaneous Agnosia** - only one object at a time
        - **Spatial Disorientation**

        - **Oculomotor** : unable to track objects
        - **Optic Ataxia** : Unable to reach accurate to objects
    - Lesion in parieto-occipital junction
- 4 ways to perceive motion:
    - Retinal motion - object moving on retina (*Kinetic Depth Effect*)
    - Apparent movement - stationary stimuli, slightly different location
    - Induced movement - one object moves, others perception of motion
    - Motion aftereffect - afterwards, stationary objects appear to move
- Corollary Discharge Theory
    - Motion depends on 3 signals:
        - Image Movement Signal (IMS) : stimulus on receptor
        - Motor Signal (MS) : signal to eye to move eye muscle
        - Corollary Discharge Signal (CDS) : copy of motor signal
    - Evidence:
        - Damage to medial superior temporal area leads to perception of motion of stationary objects
        - Real movement neurons found in monkeys
- Movement Illusion, V1 neuron explanation
- **Oculomotor Apraxia :** Unable to move eyes purposefully
- **Akinetopsia :** Motion blindness

Memory

- Memory framework
- Working Memory
- Short term Memory
- Long term Memory
- Atkinson Shiffrin 3 stage model of memory
    - Immediate Memory (*Sensory Store*)
    - Working Memory (*Short Term Store*)
    - Long Term Memory (*Long Term Store*)
    - Forgetting
    - *Flow Diagram*

    - Sensory Memory
    - *Memory Duration Diagram*
- Visual sensory store
- Digit span test -- measure of short term memory
- Baddeley's model of working memory
    - Phonological loop
    - Visuospatial sketchpad
    - Episodic Buffer
- Long term memory:
    - Declarative
        - Episodic
        - Semantic
    - Nondeclarative (Procedural)
        - Skill
        - Priming
        - Conditioning
- Forgetting
    - Failure to consolidate
    - Failure of retrieval
    - Sleep's role
- **Amnesia :** Loss of memory and capacity to learn
    - Due to damage to hippocampal and parahippocampal region
    - **Anterograde Amnesia :** No new memories
    - **Retrograde Amnesia :** Forget past events
- **Hyperthymestic Syndrome**
    - Uncontrolled remembering of all life events
- Case of HM -- No new memories, **Anterograde Amnesia**
- Case of AJ -- Hyperthymestic Syndrome
- Case of CW -- Amnesia + Can't learn
- **Korsakoff's Syndrome**
    - Caused due to lack of thiamine (vitamin b6)
    - Common in alcoholics
    - Anterograde Amnesia

    - Gaps in memory filled with false memories - **Confabulation**

Learning and Memory

- Stages of learning
    - Acquisition
    - Storage
    - Retrieval
- **Alzheimer's Disease :** Progressive dementia
- Amygdala:
    - Emotional memory
    - Imposter Syndrome
- Prefrontal Cortex:
    - Temporal order of events
    - STM, Working M
- Phonological Loop
- Spatial learning and memory tasks -- Striatum, hippocampus
- Cerebellum : motor learning
- Amygdala : Emotional Memory
- Hippocampus : Strategy
- Cerebral Cortex : Perceptual Learning, Repetition Learning

Language

- Working memory and language links
- **Broca's Aphasia :** Ability to read, but limited writing
- **Wernicke's Aphasia :** Inability to grasp the meaning of words, language. Can still produce connected speech, reading writing severely affected.
- **Specific Language Impairment (SLI) :** Delays mastery of language
- **Dyslexia :** Learning difficulty
- **Autism :** Impaired social interaction
- Language
- Structure of Language:

    - Phonemes
    - Morphemes
    - Surface structure
    - Deep structure
    - Grammar
- Components of Language:
    - Phonology
    - Semantics
    - Grammar
    - Pragmatics
- Theories of Language development:
    - Behaviorist
    - Nativist
    - Interactionist
- Universality of language - Chomsky
- Critical Period Hypothesis
- Chomsky's hypothesis on children and its faults
- Sapir Whorf Hypothesis
- Case of LEW
- Categorical Perception Effect
- How language affects perception
- Broca's Area
    - Expressive speech area
    - Speech production and syntactic analysis
    - **Broca's Aphasia :** difficulty with speech, syntax
- Wernicke's Area
    - Receptive speech area
    - Language comprehension
    - **Wernicke's Aphasia :** comprehension difficulty
- Stroop Interference
- Somatotopy
- Plasticity