Sensorimotor Functioning

Neural Processing

Motor System = Output

Sensory System = Input

Sensory and Motor Systems

- Understanding brain-behavior relationships requires knowledge of sensory and motor systems.

Functional Anatomy of Brain-Behavioral Relationships
Properties of Cortical Organization

Hierarchical
- ranking based on modality specificity & complexity of functions

Contralateral Processing
- e.g. LH represents:
  - Right Visual Field
  - Right side of body
  - Right Ear Input (sorta)
  - Vice versa for RH

Functional Segregation
- "modules" with specialized functions

Somatosensory Processing
- External processing: Touch, pain, heat
- Internal Processing: Body position, fever
- 5 types of receptors
  - Mechanical
  - Chemical
  - Thermoreceptors
  - Nociceptors
  - Proprioceptors

Somatosensory System
- Info sent from body to
  - Thalamus
  - Contralateral primary somatosensory cortex
- Each body region is represented in a different cortex region

Generic (simplified) Pathway:
- SENSORY RECEPTOR
- THALAMIC NUCLEUS
- PRIMARY CORTEX
- SECONDARY CORTEX
- ASSOCIATION CORTEX
Motor System

- Info is sent to the body through the
- Internal capsule (then decusates)
- Spinal cord
- Muscles via contralateral projections
- Each body region is represented in different cortical region

The “Homonculus”

Testing Somatosensory Functioning

- Stereognosis
- Bilateral Simultaneous Stimulation
Chemosensory Systems

- Olfaction system
  - Information is sent from the olfactory bulb to the limbic system, then back to the frontal cortex
- Gustatory (taste) system
  - Information is sent from the tongue through the thalamus to multiple brain regions

Auditory System

- Information is sent from the cochlea through the thalamus (MGN) to primary auditory cortex (Heschel's Gyrus)
- There are both ipsilateral and contralateral inputs to the cortex from each ear

Visual System

- Info is sent from the retina through the thalamus (LGN) to V1
- Left and right visual fields are processed contralaterally
Visual System Deficits

- Cortical Blindness
- Visual Agnosia for objects, faces, etc.
- Achromatopsia
- Disconnection Syndromes
- Visual Field Deficits
- Higher-order visuospatial deficits

Visual Field Deficits

Dorsal-Ventral Visual Streams

- Dorsal “Where” Stream
  - Spatial location
  - Topographical Orientation
  - Planning and coordination of movement
  - Deficits
    - Neglect
    - Apraxia
    - Left-right discrimination problems

- Ventral “What” Stream
  - Object recognition
  - Matches visual shape to internal representation
  - Deficits: Visual Agnosia
Ventral Stream Deficits

Agnosia

- Failure to recognize previously familiar stimuli
- Modality-specific
- Not due to dementia, aphasia, or unfamiliarity with stimulus
- May be limited to particular classes of stimuli
Agnosia Examples

- Prosopagnosia: Familiar faces
- Auditory Sound Agnosia: Sounds of common objects
- Phonagnosia: Familiar people by their voices
- Tactile agnosia: What’s placed in the hand

Types of Agnosia
(Lissauer’s stage model)

**Apperceptive Agnosia**
- inability to recognize or name objects
- Cannot copy unrecognized objects
- strong evidence for sensory-perceptual disturbance

**Associative Agnosia**
- inability to recognize or name objects
- Generally can copy unrecognized objects
- Sensory-perceptual disturbance cannot explain defect

Apperceptive Agnosia
(Benson & Greenberg, 1969)
Associative Agnosia
(Farah, Hammond, Levine, et al., 1988)

Anatomy implied in Stage Model
Explanations

- Failure of perception to contact memory
- Failure of perception to contact language (visual-verbal disconnection)
- Impairment/degradation of stored representation
- Sensory-perceptual impairment

Prosopagnosia

- Inability to identify previously familiar people by facial features alone
- Intact ability to identify people using nonfacial features (voice)
- May extend to nonfacial stimuli
- May co-exist with object agnosia
- May take apperceptive and associative forms

Frequent Co-existing Signs

- Object agnosia
- Visual memory loss
- Superior visual field defects
  - Altitudinal hemianopia
  - Superior quadrantanopia
- Achromatopsia
- Topographical agnosia
Lesion Profile in Prosopagnosia

- **Bilateral occipitotemporal**
- Extent of damage determines presence of apperceptive defect
- **Unilateral (right) occipitotemporal**
- Examples from recent cases

Spared and Impaired Abilities in Prosopagnosia

**Can**
- Discriminate age
- Discriminate gender
- Recognize emotions
- Recognize faces as such
- Match faces
- Show ‘indirect’ knowledge about faces

**Cannot**
- Identify individuals
- Describe the owner of the face (semantics)
- Feel familiarity when viewing faces

Dorsal Stream Deficits

- Poor angular judgments
- Poor coordination of movement in space
- Visuoconstruction deficits
- Unilateral neglect
- Topographic disorientation
Dorsal Stream (Parietal) Deficits