Neuropsychological Aspects of Frontal Lobe Function

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Important Concepts

• Phylogenetically newest area of cortex
• Exquisite connectivity based on feedback loops
• Inhibitory/excitatory control
• Farthest removed from external environment (reflective, not reflexive)
• Highly preprocessed, convergent projections (emergent concepts)
• Only neocortical representation of the limbic system
• Motivational/emotional interaction (goal-direction)

Symptoms of Frontal Lobe Damage

• Elementary Neurological Defects
• Skilled Movement Disorders
• Language/Speech Disorders
• Memory Disorders
• Executive Deficits
• Neuropsychiatric Disturbances

Frontal Lobe Cortex

• Functional subdivisions:
  – Lateral (4, 6, 8-10, 43-47)
  – Medial (6, 8-12, 24, 25, 32, 22)
  – Inferior (11-15, 25, 47)
• Another division:
  – Motor (4)
  – Premotor (6, 8, 43, 44, 45)
  – Prefrontal (9-15, 46, 47)

Dorsolateral Loop

• Critical for executive function
• Damage produces
  – Inflexibility
  – Planning
  – Problem-solving
  – Goal-directed behavior

Orbitofrontal Loop
• Involved in social and emotional functioning
• Damage produces:
  - Disinhibition
  - Hyperactivity
  - Emotional lability
  - Aggressiveness
  - Reduce self-awareness

14 Medial Frontal Loop
• Important in behavioral activation
• Damage results in
  - Akinetic mutism
  - Abula
  - Impairments in spontaneous initiation of behavior

15 Neuropsychological Domains
• motor activity
• attention
• personality/emotion
• perceptual organization
• spatial/visual function
• memory
• cognitive skills
• executive skills

16 Elementary Neurological Deficits in Frontal Syndromes
• Contralesional hemiparesis
• Re-emergence of primitive reflexes

• Gaze abnormalities (spontaneous eye-movements, conjugate gaze)

17 Frontal Lesions and “Personality” (overall ‘emotional tone’)  
• orbital syndrome
  - emotional lability
  - disinhibition
  - exaggeration of pre-existing personality traits
• medial/ lateral syndrome
  - abula/apathy
  - depression-like presentation
  - defects in self-initiation

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19 Frontal Lobe Symptoms Relevant to Emotion and Personality
• NOT independent of cognitive impairments
• Poor self-monitoring and self-reflection
• Defective arousal and orienting responses
• Affective changes
- Witzelsucht and Moria (Oppenheim)
- Depression with lack of concern
  - “Acquired sociopathy” (Damasio) – unconcern for punishment

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21 Somatic Marker Hypothesis
- Biasing signals from body are integrated in the decision-making and emotional parts of the brain (VMPFC) and used to regulate decision-making under uncertainty
- Markers signal value and bolster attention and working memory
- Case EVR (tumor of VMPFC) – became unable to make decisions despite good NP performance; unsuitable choices for business partners, friends, etc.
- EVR impaired in psychophysiological responses to positive and threatening information
- Much of the data for SM hypothesis is based on the Iowa Gambling Task

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28 Motor Deficits in Frontal Syndromes
- Two dominant behavioral syndromes:
  - hyperactivity
  - apathy/abulia
- Contralesional hemiparesis; in less severe form, contralateral reduction in speed or dexterity
- Ideomotor apraxia – impaired skilled movement in nonhemiparetic hand/extremity
- Motor impersistence- failure to maintain motor activity; test with eye closure, tongue protrusion
- Impaired verbal control over conscious motor acts - inability to invoke verbal rules(e.g., Go-No Go); inability to use verbal intentions to guide behavior (e.g., don’t drink the water)

29 Motor Deficits (cont’d)
- Defects in motor programming and sequencing - recursive writing sequences
- Impaired guidance and error correction
- Poverty of movement without weakness, hemiparesis, or abnormality in tone (intentional disorder)

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33 Tests of Frontal Motor Function
- hand-grip strength
- finger tapping speed
- static steadiness
- manual dexterity
- maze coordination
• complex tests of praxis

34 Frontal Lobes and Attention
• Inhibition/gating of sensory transmission through thalamic interaction

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38 Attentional Defects in Frontal Disease
• attention-focusing
• attention-maintenance
• attention-selectivity
  – interference susceptibility
  – Poor goal-dependent filtering of irrelevant stimuli
• attention-shifting

39 Tests of Attentional Function
• span tests (DS, Sentence Rep)
• cancellation tasks (simple and conditional)
• sustained attention
  – PASAT
  – Trail Making Test
  – Digit Symbol
• qualitative features from other tests

40 Frontal Lobes and Memory
• Classic studies of delayed response (DR) and delayed alternation (DA)
• Dorsolateral and frontal polar lesions produce greatest deficits
• DR = dorsal?
  DA = ventral?

41 Human Frontal Memory Defects
• Short-term memory
  – deficits in working memory
• Learning
  – susceptibility to proactive interference
  – shallow semantic encoding
  – impairment in “voluntary memorizing”
  – impaired “directed forgetting”
• Long-term memory
  – recall deficits relative to recognition
  – impaired memory for temporal order
  – impaired recency judgments
  – Contamination of “true memory” with “inert stereotypes”
Table
Grill
Ounce
Crayon
Fable
Pencil
Grill  Fable

Human Frontal Memory Deficits (cont’d)
- Impairments in “metamemory”
  - failure of emergent awareness
  - poor self-monitoring and self-correction
  - poor knowledge of content of memory system (e.g., poor connection between search and FOK)
  - deficits in source memory
  - poor strategy use
  - impaired memory for self-generated responses

Frontal “Executive” Skills
- a working definition of “executive” skill
- relevant skill domains
  - planning
  - goal establishment
  - anticipation
  - cognitive estimation
  - hypothesis testing (TOTE)

Cognitive Deficits in Frontal Syndromes
- impaired abstract thinking
  - tendency to interpret abstract concepts concretely (e.g., proverbs, similarities)
  - tendency to be “pulled” to more immediately available sensory information
- impaired verbal reasoning
- impairments in memory
  - organizational role
  - informational - specific memory capacities of frontal lobe (e.g., working memory; retrieval)
Tests Tapping ‘Frontal’ Cognitive Defects

- Wisconsin Card Sorting Test
- Halstead Category Test
- Shipley-Hartford Analogic Reasoning
- Trail-Making A and B
- Porteus Mazes (planning)
- Constructional Tasks (ROCF, BD)
- practically any other test calling for response production and organization!

Theories of Frontal Lobe Function

- Pribram (1960): Feedback
- Teuber (1964): Corollary discharge
- Nauta (1971): interoceptive (limbic) and exteroceptive (sensory, association) connectivity
- Fuster (1980): temporal organization
- Shallice (1978): information processing
- Luria (1973): hierarchical model