Clinical and Experimental Neuropsychology

Lecture 2: Neuropathology and Neuropsychological Assessment
Lecture Outline

1. Major types of neuropathology
   a) Head Trauma/Brain Injury (penetrating vs. closed head)
   b) Vascular Disorders
   c) Degenerative Disorders (e.g. AD or PD)
   d) Toxic Conditions (e.g., alcoholism, substance abuse)

2. Neuropsychological assessment
1. Major Neuropathologies

“Brain injury is a process, not an event.”

Johnson, 1999
(a) Traumatic Brain Injury (TBI)

- Most common form of brain damage; in EU 250 per 100,000 of the pop. suffer head trauma requiring hospitalisation
- Mortality rate average 5%-10%
- More incidents in urban areas
- Age distribution: 15-24 and 65+
- Twice as many males as females Cause: RTA, falls, assaults, accidents, gunshot

www.headwayireland.ie
www.peterbradleyfoundation.ie
a) TBI

(i) PHI

- Skull opens & objects travel through the brain tissue

(ii) Closed Head Injuries (CHI)

- Gunshot wounds = most common cause
Prevalence and Psychological Correlates of Traumatic Brain Injury in Operation Iraqi Freedom

Andrew J. MacGregor, PhD, MPH; Richard A. Shaffer, PhD, MPH; Amber L. Dougherty, MPH; Michael R. Galanneau, MS; Rema Raman, PhD; Develene G. Baker, MD; Suzanne P. Lindsay, MSW, MPH, PhD; Beatrice A. Golomb, MD, PhD; Karen S. Corson, PhD

Objective: To describe the prevalence and psychological correlates of traumatic brain injury (TBI) among injured male combatants in the Iraq conflict. Participants: A total of 781 men injured during military combat between September 2004 and February 2005. Main Outcome Measures: Mental health diagnosis (ICD-9 290–319), particularly posttraumatic stress disorder and mood/anxiety disorders, assessed through November 2006. Results: 15.8% met criteria for TBI (13.4% mild, 2.4% moderate-severe TBI), 35.0% other head injury, and 49.2% non-head injury. Multivariate logistic regression suggested lower rates of posttraumatic stress disorder and mood/anxiety disorders among those with mild and moderate-severe TBI. Conclusions: These findings could reflect a problem with differential diagnosis or, conversely, a low rate of self-presentation for symptoms. Further research is needed to elucidate the psychological consequences, clinical implications, and overall impact of TBI among military combat veterans. Keywords: military, posttraumatic stress disorder, PTSD, traumatic brain injury.

Traumatic Brain Injury (TBI) is defined as brain damage secondary to an externally inflicted trauma and is a significant source of morbidity among those who experience an increased level of consciousness, and hyperarousal, is a potentially important sequel of TBI.4,5 Research on the relation between TBI and PTSD has...
(i) Penetrating Head Injury (PHI)

- Produces a focal lesion and is associated with shock waves and pressure effects.

- Associated with **ischemia** (partial occlusion of an artery/capillary); **oedema or hematoma** (swelling); **infection**

- If person survives then most recovery of function is evident in yrs 1-2 post injury

- **Seizures** are a secondary consequence - 15 yr follow-up of Vietnam War veterans showed that 50% had post-traumatic epilepsy, 28% persistent epilepsy

- Cognitive and behavioural deficits **vary widely** - will depend on lesion site and size, patient characteristics etc
(ii) Closed Head Injury (CHI)

- Acceleration/Deceleration Injuries – forward or sideways

- Primary & secondary injuries (coup & countercoup)
  - Cause swirling movements throughout the brain
  - Diffuse axonal damage.
  - Often affects white matter

- Vascular structures may be affected secondarily
Glasgow Coma Scale for Head Injury

**Glasgow Coma Scale, Eye opening**
- Spontaneous: 4
- To loud voice: 3
- To pain: 2
- None: 1

**Verbal response**
- Oriented: 5
- Confused, disoriented: 4
- Inappropriate words: 3
- Incomprehensible sounds: 2
- None: 1

**Best motor response**
- Obey: 6
- Localizes: 5
- Withdraws (flexion): 4
- Abnormal flexion posturing: 3
- Extension posturing: 2
- None: 1

- **Range = 3 – 15 points**
- **Classification**
  - Mild: > 13 or < 20 minutes
  - Moderate: 9 - 12 or no longer than 6 hrs
  - Severe: ≤ 8 or > 6 hrs
Post-traumatic Amnesia (PTA)

Period following trauma during which no new memories are laid down, or at least only intermittently:

- PTA is a good indicator of severity:
  - Less than one hour- very mild / mild head injury
  - 1-24 hours- moderately severe head injury
  - 1-7 days- severe head injury
  - >7 days- extremely severe head injury
(ii) Closed Head Injury (CHI)

**Symptoms & Patient Complaints**

<table>
<thead>
<tr>
<th>Headaches</th>
<th>Dizziness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea</td>
<td>Noise sensitivity</td>
</tr>
<tr>
<td>Sleep disturbance</td>
<td>Fatigue</td>
</tr>
<tr>
<td>Irritable/temper outbursts</td>
<td>Depressed/tearful</td>
</tr>
<tr>
<td>Frustrated, impatient</td>
<td>Poor concentration</td>
</tr>
<tr>
<td>Taking longer to think</td>
<td>Blurred vision</td>
</tr>
<tr>
<td>Light sensitivity</td>
<td>Double vision</td>
</tr>
<tr>
<td>Restlessness</td>
<td></td>
</tr>
</tbody>
</table>
(ii) Closed Head Injury (CHI)  
- Neuropsychological Impairments

☐ Mild to Moderate CHI (no or minimal PTA or loss of consciousness):
  - Attention deficits
  - Impaired verbal retrieval
  - Emotional distress

Course-depends on a variety of factors but most investigators have found that these deficits resolve in ~3months, but there is always a residual non-resolving group.
(ii) Closed Head Injury (CHI)  
- Neuropsychological Impairments

Severe CHI- associated with a host of long-term cognitive and behavioural deficits:

- Attentional deficits and behavioural slowing (both mental and motor)
- Memory Deficits – short term & working memory
- Hyper-distractibility and perseveration
- Deficits in self-awareness, empathy, self control and orientation to the future.
- Impaired frontal lobe /**executive function** (planning & organising tasks, cognitive control and flexibility)
(ii) Closed Head Injury (CHI)
- Outcome

- Most recovery is made within 6-9 months of the TBI incident, but there can be some change after this (even after long periods of time)
- Moderating variables: age, premorbid factors (IQ, education), repeated head trauma...

- Restoration of vs compensation for function
1b Vascular Disorders

Stroke: the most common cause of death worldwide

- Strokes and related disorders
- Strokes – 150 / 100,000 in the US
  Likely to be more “silent” & painless strokes
- Leading cause of disability + 60 yrs
b) Vascular Disorders – Major Arteries

- ACA
- MCA
- VA
- PCA
- PICA
b) Vascular Disorders - pathophysiology

Stroke or cerebrovascular accident (CVA)

- Blood flow is restricted/stopped or too pervasive.
- Area of damaged/dead tissue = infarct
- Onset
  - brainstem infarct: loss of consciousness & death within minutes
  - cortical infarct: loss of speech, motor functions or comprehension

Other types/terms to note:

- Ischemia - partial occlusion of an artery or capillary, or drop in BP, causing insufficient blood flow & tissue starvation
- Cerebral arteriosclerosis - persistent ischemia (thickening/hardening of arteries-associated with high BP)
- Hemorrhage - sudden rise in BP- bleeding over wide area due to blood vessels breaking
- Aneurysm - bulged blood vessel expands and bursts
- Arteriovenous malformations (AVM) – congenital tangled mass of arteries & veins, may grow & rupture
b) Vascular Disorders-

Symptoms & patient complaints

- wide range of symptoms again, but: damage less diffuse than TBI
- Symptoms depend on location
- General: fatigue, mental & motor slowing, irritability
(c) Neurodegenerative disorders

- Incidence increasing due to aging populations
  Lecture 9, http://www.tcd.ie/tilda/

- Estimated 3 – 4 million dementia patients in US

- Dementia = cognitive decline associated with a progressive brain disease

- Most distinguishable from each other in early stages
Cerebral atrophy = shrinking of the brain, space fills with cerebrospinal fluid instead
# Neurodegeneratives contd - Major Disorders

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Type / Classification</th>
<th>Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alzheimer’s Disease</td>
<td>Cortical</td>
<td>Tangles and plaques in limbic and temporal-parietal cortex</td>
</tr>
<tr>
<td>Parkinons’ Disease</td>
<td>Subcortical</td>
<td>Neuronal loss in the substantia nigra, dopamine depletion in the basal ganglia &amp; SN</td>
</tr>
<tr>
<td>Huntington’s Disease</td>
<td>Subcortical</td>
<td>Atrophy in caudate nucleus and putamen (striatum)</td>
</tr>
<tr>
<td>Progressive Supranuclear Palsy</td>
<td>Subcortical</td>
<td>Brainstem atrophy including colliculus (upper brain stem to basal ganglia)</td>
</tr>
</tbody>
</table>
Brief Communications

Nature 404, 721-722 (13 April 2000) | doi:10.1038/35008142

Delaying the onset of Huntington’s in mice

Anton van Dellen¹, Colin Blakemore¹, Robert Deacon², Denis York³ & Anthony J. Hannan¹

Huntington's disease is an inherited (autosomal dominant) disorder in which there is progressive neurodegeneration, affecting the corpus striatum and cerebral cortex of the brain, and for which there is no known cure. Transgenic mice have been created¹,² that develop a neurodegenerative syndrome that closely models the human disease. Here we show that exposure of these mice to a stimulating, enriched environment from an early age helps to prevent the loss of cerebral volume and delays the onset of motor disorders.

1. University Laboratory of Physiology, University of Oxford, Parks Road, Oxford OX1 3PT, UK
2. Department of Experimental Psychology, University of Oxford, Oxford OX1 3UD, UK
3. Department of Virology, University of Natal Medical School, Durban, South Africa

Correspondence to: Anton van Dellen¹ e-mail: Email: avd@physiol.ox.ac.uk
c) Neurodegenerative Disorders

Assessment of Degenerative Disorders

- Neurologists will focus on deterioration of motor and cognitive function early in the course
- Neuropsychologists focus on:
  - Ability to learning new material and form new memories
  - Autobiographical or episodic memory
  - Semantic memory
  - Executive function (planning, organising) and attention
  - Response to medication (?)
d) Toxic Conditions

- Due to substances which disturb neuronal functioning

- Neuropsych assessment: mainly alcohol-related conditions:
  - cerebral atrophy (white matter > gray matter)
  - dorsolateral frontal & parietal region atrophy
  - Reduced dendritic growth in hippocampus and cerebellum
Korsakoff’s syndrome

- Neuropsychological syndrome associated with chronic alcohol abuse
- Mainly gross memory impairment with some disordered movement
- Slowed visual & auditory processing
- Attentional impairments (esp divided att)
- Short term recall often unimpaired, but info outside of “3-5 min time zone” often disordered or unavailable
- Confabulation & often oblivious to chronology
Lecture Outline

1. Major types of neuropathological disorder.
   a) Head Trauma (penetrating & closed head)
   b) Vascular Disorders
   c) Degenerative Disorders
   d) Toxic Conditions

2. Neuropsychological assessment procedures.
Neuroradiology

CT or MRI scans - exact location and size of the lesion are determined. Best practice: lesions evaluated with respect to size and location by 2 neuroradiologists.

Analysis of MR images is based on degree of oedema and hemorrhage, lesion location and volume, degree of diffuse lesion.

Residual structural deficits should be examined 6-12 months post-TBI.

Awareness that many cognitive functions are performed by networks of regions, not single foci.
New Priorities for the Neuropsychologist

- Functional Imaging and Managed Health Care

- Identify measures that are linked to treatment choice and outcomes

- Time and cost efficiency

- Treatment planning, monitoring and outcome evaluation
Reason for referral

- Neurological Disease: 21%
- Psychiatric: 20%
- Rehabilitation: 29%
- Learning disabled: 10%
- Forensic: 7%
- Dementia: 5%
- Other: 8%
Scenario: Patient is admitted with Traumatic Brain Injury, then…?

Steps:

1. Standard medical procedures to ensure survival

2. Neurological examination

3. Neuroradiography

4. Neuropsychological Assessment
Neuropsychological assessment (Kipps and Hodges 2005)

- Typically about 1-2 hours long

- Objective: to provide a profile that comprehensively details a patient's abilities and disabilities. The latter can then be targeted for neurorehabilitation (Lecture 11)

- Time pressure – clear focus required

- Infer premorbid Brain Function

- Inferring *functional* brain status

- A full test battery should be administered

- 6 & 12 months after initial assessment, patients should be re-tested and examined regarding ADL, psychosocial functioning, adjustment and coping
Most clinical neuropsychologists adopt a **flexible** approach

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Test should…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuropathological sensitivity/</td>
<td>… demonstrate specific relationship to localised damage and/or dysfunction</td>
</tr>
<tr>
<td>specificity</td>
<td></td>
</tr>
<tr>
<td>Cognitive domain specificity</td>
<td>… assess different cognitive domains</td>
</tr>
<tr>
<td>Construct specificity</td>
<td>… derive from/fit within theoretical framework of neuropsychological function</td>
</tr>
<tr>
<td>Feasibility</td>
<td>… be feasible and reliable (test administration and scoring)</td>
</tr>
<tr>
<td>Individual Relevance</td>
<td>… be relevant to psychosocial functioning and cognitive rehabilitation, <em>i.e.</em>, How does impairment to this function hinder rehab and psychosocial function?</td>
</tr>
</tbody>
</table>
## Conditions following localised lesions

<table>
<thead>
<tr>
<th>Inattention</th>
<th>Dysexecutive problems</th>
<th>Dyspraxia- impairment of sensory-motor integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemiparesis-inability to use side of the body</td>
<td>Amnesia</td>
<td>Aphasia-impaired speech</td>
</tr>
<tr>
<td>Category specific linguistic problems</td>
<td>Agnosia-problems of knowing or recognizing</td>
<td>Simultanagnosia (Balint’s syndrome)- difficulty attending to more than one part of the visual field</td>
</tr>
<tr>
<td>Prosopagnosia-impaired face recognition</td>
<td>Disconnection Syndromes</td>
<td>Hemianopia/blindsight- cortical blindness from lesions of V1 but with residual awareness for object location.</td>
</tr>
<tr>
<td>Unilateral neglect- unawareness of event, objects etc in the contralateral visual field</td>
<td>Dysgraphia-difficulties with writing</td>
<td>Mind blindness</td>
</tr>
</tbody>
</table>
Domains to assess...

- Activities of daily living
- Memory
- Attention
- Language
- Executive functions (planning, initiation, cognitive control & self-regulation)
- Perceptual Processing
- Emotional outcome / mood
- Levels of insight into problems
Standardized tests...

- Need tests that have a basis in Neurological theory
- Need to take account of demographic variables and their impact on performance
- Perceptual: Visual, Object & Space Perception Battery (VOSP, Warrington & James, 1991)
- Memory: Wechsler Memory Scale III (11 subtests):
  - Orientation
  - Logical Memory
  - Recall of Faces
  - Verbal Paired Associates
  - Family Pictures
  - Word Lists
  - Visual Reproduction
  - Letter-Number Sequencing
  - Spatial Span
  - Mental Control
  - Digit Span
Trail Making Test - Motor vs cognitive slowing

Scoring: e.g. - time B – time A
- errors on B
Evidence for unilateral spatial neglect following right parietal lobe damage

- Constant need for development of new tasks
- Experimental neuropsychology constantly informs clinical practice
Variables affecting neuropsychological test performance

- Nature & extent of injury (location)
- Age and other demographics
- History: - pre-morbid ability
  - onset/time course of symptoms
  - co-morbid issues
- Alertness & co-operation

- Test anxiety

Neuropsychologist must be flexible

Testing for deficits
No clear “right and wrong”
Why Neuropsych?

- Organic brain dysfunction?
- Nature & extent of impairment
- Practical & functional consequences of the cognitive impairment(s)
- Mood disorder, directly or secondarily due to brain injury?
- Change over time? recovery or decline
- Implications for rehab planning. Areas of severe impairments, areas of retained strength
- Inform surgical decisions
- Malingering?
References


