

SEVERE HEAD INJURY: WHAT CAN NEUROPSYCHOLOGY DO?

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Introduction

Head injury (HI) is a major public health problem in most developed countries, causing brain damage, enormous medical efforts and high economic costs. Advances in emergency evacuation and neurosurgical management of HI have reduced mortality, resulting in a large population of chronically disabled survivors with multiple neurobehavioural deficits. This review briefly elucidates the present role of neuropsychology in subjects who have suffered severe craniocerebral trauma.

The neuropsychological approach

Neuropsychology evaluates the effects of brain damage on cognitive skills and intellectual functions, such as language, memory, visuospatial abilities, recognition processes, and executive functions, to name a few. Neuropsychological methods are functional, specific, and problem oriented: they investigate behavioural functions over time, not morphology like brain imaging or pathology; they attempt an individual exploration of behaviour on the basis of personal background variables like age, premorbid intelligence, professional skills and personality; and they take each patient's disease variables specifically into account: the type of brain lesion, the character of the resulting behavioural deficit, its prognosis and approach to recovery. Although group studies have played a major role in evaluating behavioural syndromes and in developing standardized assessment procedures, neuropsychology has traditionally been engaged in single case studies of brain damaged subjects. Several methodological and practical issues suggest that a single-case approach in neuropsychological diagnosis and treatment is preferable to the use of fixed test batteries and rehabilitation programs for a heterogenous group like HI patients. The following survey presents two main involvements of neuropsychology in HI, namely the assessment and remediation procedures of cognitive impairment.

Behavioural deficits and their assessment in head injured patients

Contusions, penetrating injuries, hematomas, diffuse white matter injuries, brain edema and ischemic necrosis are the most frequent causes of a large range of cognitive impairments in HI. Especially in blunt HI, these lesions are most marked in the dorsolateral and orbitofrontal, anterior and mesial temporal, brainstem and callosal areas; however, many other lesions sites leading to behavioural deficits have also been described. Different from a stroke, a well investigated paradigm of single, "focal" brain injury, lesions in HI often tend to be less well localized, and are often multiple. Consequently, most HI patients have clusters of behavioural deficits resulting from multifocal frontal, temporal and diffuse brain injury. In the early period after HI cognitive evaluation is a complex, time consuming and arduous procedure due to lack of attention, cooperation and the severity of impairment; it often results in the tentative diagnosis of multimodal, overlapping and partly interdependent deficits. However, during chronic stages of HI specific and relatively well-defined neuropsychological syndromes can be found in many patients. Table 1 summarizes the most frequent cognitive syndromes in head injured patients.

Table 1: Neuropsychological syndromes in severe head injury

Deficits of attention
Impairment of learning and memory
Frontal lobe syndromes
Aphasia
Impairments of motor speech
Apraxia
Visuoperceptual, visuospatial and constructive impairments
Other cognitive deficits (disorders of perception and recognition, disconnection syndromes etc.)
Affective, personality and psychosocial disturbances

Attentional deficits are basic, universal, long lasting sequelae of HI even in patients with mild brain damage; in many cases they present severe problems for assessment and therapy attempts. Inattention may become variably manifest as poor concentration or vigilance, mental fatigability, inability to focus on a selective target, or loss of sustained or supervisory attentional control. In addition, hemi-inattention or neglect, a syndrome where patients fail to explore or to respond to one half of space or of their body can also be found in HI subjects. Clinical measurements of attention include various psychometric tasks such as mental tracking or tests of serial addition (PASAT) requiring supervisory

control, mental speed and information processing capacities. Screening for neglect includes bilateral simultaneous visual or tactile stimulation, cancellation and bisection tasks.

Post-traumatic amnesia and residual disturbances of learning are characteristic features of HI resulting from both, diffuse and focal (temporal, diencephalic and frontal) brain lesions, and leading to a state with disorientation, impaired memory for episodic events before (retrograde) and after (anterograde) injury. Amnesia in HI patients is usually multimodal including verbal and nonverbal materials; it affects recall, recognition and temporal ordering of autobiographical, historical and ongoing facts, commonly abolishing younger more than old or very long term memories. In most HI patients, amnesia represents one of the main obstacles for a return to normal everyday life and employment. Assessment of amnesia includes learning, recall and recognition of working memory with different materials such as word lists (e.g. the California Verbal Learning Test), prose, associate word pairs, pictures and geometrical designs, but also everyday memory capacities like picture, face or name learning, remembering appointments and hidden belongings, or skill learning (the Rivermead Behavioural Memory Test).

Aphasia has been observed in the majority of severely head injured patients; it occurs predominantly in subjects with penetrating wounds or contusions of the dominant hemisphere and is often associated with focal neurological signs and posttraumatic seizures. Frequent features of traumatic aphasia are anomia or Wernicke's aphasia with fluent paraphasic speech, poor comprehension of oral and written language and impaired repetition. Broca's aphasia with nonfluent agrammatic language seems to occur rather rarely in blunt HI but may be found after left frontotemporal missile or stabbing injuries. Other, more subtle impairments of linguistic knowledge include word list generation, and discourse with tangential, confused or inappropriate language, lack of cohesion and informational content. Aphasia is tested by use of various standardized examinations, e.g. the Aachen Aphasietest, comprising the assessment of spontaneous speech, comprehension, repetition, naming, reading and writing.

Dysarthria is a common articulatory disorder in HI patients; it often accompanies aphasia during the early stages and may persist after restoration of other language capacities. Most traumatic dysarthrias are mixed pseudobulbar-bulbar speech syndromes with spastic, rigid and ataxic components clinically presenting as poorly articulated, slow speech with impaired control of voice qualities, loudness, stress and timing; traumatic dysarthria usually results from multiple coexisting lesions in the cortex, white matter, basal ganglia, brainstem and cerebellum. Less frequent nonaphasic sequelae of HI are apraxia of speech, an articulatory disorder resulting from defective speech programming, traumatic

mutism, a central impairment of phonation found frequently in early stages of recovery from HI, echolalia and stuttering. Evaluation of dysarthria includes the assessment of rate, loudness, voice, articulation, intelligibility, prosody, and respiration in spontaneous speech, repetition and reading aloud.

Apraxia, by definition a deficit in planning and performing motor action is difficult to assess because of frequent concomitant lower level motor and object recognition deficits in HI patients; also, goal directed action is often disturbed by a coexisting dysexecutive or frontal lobe syndrome forcing the patient to organize and perform multistep actions through appropriate action strategies and feedback control. Characteristics of apraxia from HI include general action disorganization, loss of action sequence, misuse of objects, recognition and execution deficits of symbolic movements, and poor imitation of single and multiple limb and orofacial movements. Apraxic patients display a number of typical movement errors, among them substitutions, omissions, perseverations and "body-part-as-object" errors. Apraxia is tested separately for limb, orofacial and axial movements using verbal commands or imitation procedures; during assessment of ideational praxis, patients are required to perform ecologically valid action sequences like preparing meals, mailing letters, etc.. Many head injured patients suffer a severe and enduring frontal lobe syndrome with loss of spontaneity, disinhibited social and sexual behaviour, perseveration, distractibility, impaired temporal orientation and accompanying Korsakow-like amnesia. Other, higher-order frontocognitive impairments are poor adaptation to changing situations and a problem solving deficit; this so called "dysexecutive syndrome" becomes especially apparent in novel situations which cannot be overcome by strong habitual responses but involve planning, decision making, strategy generation and execution, feedback-mechanisms and error correction. Some authors favor a behavioural and anatomical differentiation of frontal brain syndromes into an orbitofrontal syndrome with "pseudopsychopathic" features (i.e. lack of impulse control, irritability and/or hyperkinesia) and a fronto-convex, "pseudo-depressed" syndrome (slowness, apathy, diminished initiative, and indifference). The clinical evaluation of frontal brain syndromes is manifold and comprises, for example, word and design fluency, the Stroop test, conceptual thinking paradigms (e.g. proverb interpretation, Category Test), various sorting (e.g. Wisconsin Card Sorting Test), reasoning (e.g. Raven's Progressive Matrices) and problem solving tasks. Finally, an analysis of psychopathological symptoms is crucial in frontal lobe syndromes. It is important to recognize that frontal injury can influence psychometric measurement of other, "nonfrontal" functions as well because of these patients' inability to use acquired knowledge, their distractibility, perseverativeness, inflexibility and lack of mental effort.

Visuoperceptual, visuospatial and constructive abilities are frequent sequelae in HI patients with right or left posterior, mostly occipital brain damage,

among them visual acuity and visual fields, perception of color and angulation, stereopsis, or oculomotor functions. An outline of measurements includes basic neuroophthalmological functions, acuity thresholds, color vision, perimetry, and contrast sensitivity; useful clinical tests are line orientation, maze tasks, tests for geographical and personal orientation, figure copying and free drawing, and various assembling procedures for measuring three-dimensional constructive abilities (e.g. the Block Design subtest of the WAIS).

Other cognitive deficits after HI include perceptual disorders of hearing and olfaction as late sequelae of skull fractures, impairments of visual recognition (prosopagnosia, visual agnosia, simultanagnosia) from occipital, temporal and parietal lesions, hemispheric (mostly subclinical) disconnection syndromes due to axonal injury in the corpus callosum, and rare disorders stemming from frontal injury such as the alien hand syndrome, or imitation and utilization behaviour syndromes.

In addition to intellectual loss HI generally induces affective, personality and psychosocial disturbances, most of them associated with brain damage, but some possibly having a psychological and sociological basis. After regaining consciousness and in early remission periods HI patients often display variable transient psychoorganic syndromes including disorientation, disturbances of sleep-wakefulness cycle, hallucinations, increased psychomotor activity, marked aggressive behaviour, mood disturbances including manic or depressive symptoms and general emotional instability. Patients in the chronic stage of HI often display personality changes, mostly subsumed under the term "frontal syndrome" with lack of concern, coarseness, euphoria, disinhibition and increased sexuality, emotional lability and loss of insight. Other frequent chronic psychic changes after severe HI are depression, loss of interest and motivation, increased somatic concern, apathy, indifference or emotional withdrawal; and the postconcussional syndrome including anxiety, insomnia, inability to concentrate and cope with stress, and repeated complaints of headache, chronic fatigue, vertigo, drowsiness or blurred vision. In a high percentage of HI patients cognitive and personality changes and chronic disability induce psychosocial disturbances with negative impact on familial relationships, employment and general social life. Psychological changes in chronic HI require a carefully balanced analysis of the patient's neurological and cognitive findings, his psychological status, and his preexisting social and emotional situation. Guidelines to a psychological diagnosis which is hard to objectivize but sometimes of forensic interest, are "hard" clinical symptoms, behavioural observation and rating procedures, and a skillful psychiatric interview.

Cognitive remediation

A large and growing body of literature and the appearance of new facilities

specially designed for cognitive rehabilitation indicates that the traditional view of neuropsychology has changed from a purely diagnostic to both, an assessment and an interventional tool. Cognitive therapy is impeded by a number of novel methodological difficulties, among them the selection of patients with promising outcome variables, the design of specific therapy programs with ecological validity, the evaluation of program efficacy, and many practical problems such as the planning, content, level and frequency of training sessions, the didactic approach, type of material and eventual employment of automated programs to be used. Absolute prerequisites of cognitive therapy are an analysis of patient and disease variables, initial and longitudinal monitoring of major cognitive deficits, planning of therapy goals, selection of training procedures and materials, and documentation of recovery. To cope with the multidisciplinary aspects of cognitive remediation most therapy centers employ neurologists, psychologists, speech and language pathologists, ergo- and cognitiotherapists for a cooperative therapy program. A small selection of remediation approaches with promising results in HI patients is listed below.

Methods for amelioration of attention disorders train the patient to scan, detect and respond to environmental signals and cues, to improve concentration on internal sources such as time estimation exercises, or to synchronize with complex rhythms, and have shown to correlate with Mychometric and clinical variables; other attempts of neglect therapy feature auditory feedback training, or the correction of the displaced subjective midline via vestibular stimulation.

Rehabilitation of memory disorders has become a major issue in neuropsychological rehabilitation and includes several approaches. Patients with a severe amnesic syndrome will profit from organizing their surroundings, e.g. by external memory aids like alarms, biographical cues for personal and landmarks for local orientation, timetables and activity lists for the day, but also by maintaining the local set and a small number of caregiving persons as long as possible. More specific memory training aims at the development of mnemonic strategies, e.g. learning of face-name associations by use of affective and phonological cues, or will try to induce semantic elaboration via search for striking characteristics among the material to be recalled. Other strategies for recall of single items or names try to evoke visual imagination, use "the method of loci", concentrate on phonological cues like the initial letter, or embed to-be-learned items in short stories. In amnestics, recall of prose and other textual information has been shown to profit from activation of related knowledge, the generation of questions about the text, a profound discussion or some other detailed analysis of the relevant information. Other mnemonic remediation techniques include operant reinforcement schedules, cognitive retraining by teaching patients necessary skills rather than mnemonic strategies, procedural learning as a memory aid, or compensatory techniques.

Speech and language therapy is probably the most developed intervention procedure and also has a well-based knowledge of prognostic factors of recovery. Classical aphasia therapy includes, for example, stimulation therapy, where access to language modalities is facilitated in response to particular stimuli; Luria's approach trying to achieve recovery through reorganization of functional systems and transfer of affected functions to new structures; or neurolinguistic approaches like melodic intonation therapy or deblocking techniques. Modern aphasia rehabilitation concentrates on two efforts: to recover modality specific deficits in comprehension, lexicon and semantics, phonology and syntax, and to improve the communicative abilities of aphasic patients, e.g. by the PACE-technique, group or family therapy, or by computer-based aphasia treatment. Remediation of reading and writing disorders, or word finding difficulties follows separate therapeutic principles. Compensation for dysarthria is achieved by making the speaker continuously monitor his performance; by a step-by-step articulation training program which includes speech rate modification, deliberate syllable-by-syllable production, consonant exaggeration, and practising of difficult phonemes; and by adjustment of respiration, pitch, loudness, vocal qualities and prosody to improve audibility, intelligibility and emphasis. Special methods have been developed for mixed and spastic dysarthrias as found in head injured patients.

Though verified only in small groups, treatment of reasoning and problem solving disorders in brain injured patients can be fairly successful. Several recent studies used problem-solving training specifically designed to improve problem formulation, strategy and alternatives generation, decision making and solution verification. To enhance these capacities, patients were requested to produce goal-directed ideas, discriminate between relevant and irrelevant information, and to selectively combine problem related information in small group training sessions. Results indicated positive treatment effects as measured psychometrically by behavioural ratings and planning test scores. Other authors have tried similar programs, among them forms of motivational and awareness training, exercises to develop abstract reasoning, concept formation and productive thought for practical problems, and training to utilize cues and shift response sets. Alternative programs use forms of positive reinforcement, cognitive overlearning and comparable behaviour modification techniques.

Computer based retraining and sensory cueing methods have been elaborated for patients with visual field losses, other forms of visual imperception or lateral scanning disorders to regain basic visual perceptual functions, visual searching, but also more skill-demanding processes like reading, route finding or driving. Finally, remediation procedures for visual recognition deficits like object and face recognition, visual closure, and spatial integration are now being developed, mostly in single-case studies.

Conclusions

As evident from this review, neuropsychology in patients suffering from HI is still strongly biased towards diagnosis and assessment procedures, compared to the rather short tradition and limited experience of neuropsychological rehabilitation. Similarly, every attempt to improve the cognitive impairment of HI subjects shows that successful remediation is more difficult to initialize and perform, and also takes a lot more endurance and patience than mere assessment of cognitively impaired patients. However, after decades of research in the fields of imaging, pathophysiology and diagnostic measurement, it may now be time to accept cognitive rehabilitation as one of the forthcoming issues, and to accept neuropsychology as a promising domain in the management of severe head injury.

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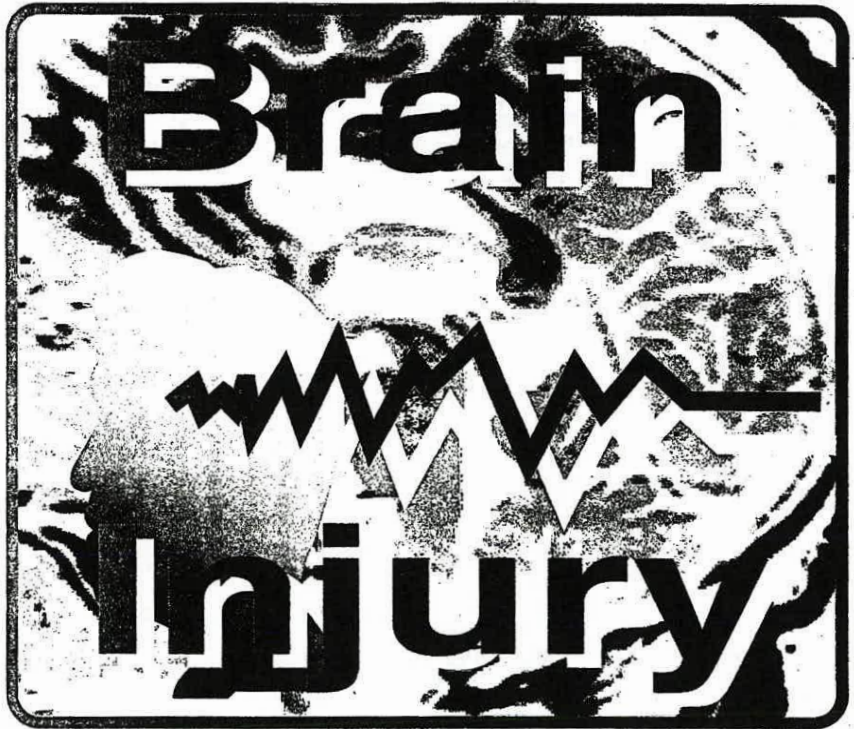


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