Case Report

Traumatic Prefrontal Encephalopathy and Amotivational Apathetic Syndrome: Revisiting the Historical Limitations of Standardized Neuropsychological Assessments

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Abstract

The field of neuropsychology has made significant gains regarding the development and implementation of diagnostic measures and assessment techniques for frontal lobe pathology. Nevertheless, it is becoming increasingly evident that the existing battery of tests remains relatively insensitive to the ever-growing range of functions known to be mediated by the prefrontal regions. In the present study, a 62 year-old gentleman was involved in a pedestrian motor vehicle accident and suffered bilateral prefrontal, left parietal, and left occipital trauma (as evidenced by magnetic resonance imaging [MRI] scans). Secondary to this accident, he complained of significant depression, thought disturbances, and paranoia, while family members reported additional personality changes. A consistent diagnosis of frontal lobe syndrome was established across three independent neuropsychological evaluations, in which his postrehabilitative scores on a range of standardized assessments were consistently above average, regardless of his significant social, affective, and motivational changes following the accident. This case demonstrates the limitations and insensitivity that current standardized measures still obtain for assessing prefrontal lobe injury. The results are interpreted within the context of test development relevant to neuroscience rather than strictly psychometric concerns. The importance of these constraints on the evaluation of frontal lobe syndrome is discussed within the context of traumatic brain injury from contact sports and military combat.

Keywords: Neuropsychological assessments, amotivational syndrome, apathy; bradykinesia, frontal lobe syndrome, traumatic brain injury, TBI, traumatic encephalopathy, psychometric tests, and standardized tests.

Traumatic Prefrontal Encephalopathy and Amotivational Apathetic Syndrome:

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Historical Origins: The Frontal Lobotomy

For the healthy left frontal lobe, intentional acts involve substantial energy, the desire or intent to engage socially, and the intent to engage in positive affective and verbally interactive activities. These appear to be diminished with the amotivational syndrome arising from dysfunctional left frontal lobe origin and medial frontal

pathology with reduced activation of social reward systems and dopaminergic pathways [25, 24].

While the patient with left frontal pathology may present with diminished energy and behavioral slowing or inertia, heightened energy or "impulsivity" may result from right frontal pathology and, by inference, the release of left frontal systems (e.g., decreased caution). Both are described in the scientific literatures as "delayed response deficits." However, with left frontal pathology the patient may initiate only following inordinate delays with behavioral slowing or bradykinesia, whereas the patient with right frontal pathology may initiate substantially prior to implementing the organizational planning or caution for successful task completion. Hypoactivity bradykinesia may derive from medial frontal lobe or left frontal lobe pathology and hyperactive or "impulsive" features with pathology within the homologous regions of the right frontal lobe supplementary motor or orbitofrontal cortex [24, 29].

Neuropsychological comprehension of frontal lobe functioning has grown exponentially in scope and research specificity. In the early to mid 1900's, diagnoses of mental illness and "abnormal emotionality" began to shift towards the implication of dysfunction in specific brain regions. Potential solutions included surgical resection of the brain via frontal lobotomy or lobectomy, which rapidly grew in popularity. German physiologist Friedrich Goltz, in the late 1800's, ablated canine neocortex. Goltz's [23] reporting of character changes in his subjects influenced Swiss physician Gottlieb Burkhardt to translate this early medical intervention to human patients. Portuguese neurologist Egas Moniz [41] was

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a pioneer in the field who is known for perfecting the prefrontal leucotomy for individuals suffering from schizophrenia and other mood disorders. Postoperative reports indicated diminished paranoia and reduced anxiety levels in his patients, and this technique was deemed a medical success.

American neurosurgeon Walter Freeman later modified Moniz' alcohol injection technique and established the leucotomy method, in which he slid a pick over the orbits andinserted it through the basal skull, into the orbitofrontal region [21]. He renamed this method the "frontal lobotomy" to indicate the incision of both white and grey matter. Freeman popularized this technique in America during the 1940's and 1950's, teaching his methods to psychiatrists across the United States. Although now considered extreme, these practices were believed to be an ideal and effective means of curing mental illness at the time. The imprecise means of post-operative evaluations was not appreciated until the late 1950's, when long-term alterations in general affect and personality were finally recognized, and the popularity of this procedure began its decline.

Postoperative Results

Post-operative clinical evaluations of these patients were often favorable and involved psychometric "pencil and paper" tests, which did not yield significant changes in performance on standardized tests of memory and intelligence compared to preoperative scores on the same measures. Nevertheless, the successful emotional blunting of these patients was not achieved without sacrifices to other equally important aspects of brain function [27, 3]. Although diminished emotionality was the initial objective for these patients, family members eventually reported significant personality and behavioral changes. Damage to frontal lobe tissue, resulting in emotional blunting and changes in personality and energy levels, has now become associated with dysfunction and pathology; more formally identified as frontal lobe syndromes of the amotivational/apathetic type.

Undoubtedly, the lateralized function of the right and left cerebral hemispheres [27] dictates the specific presentation of this condition. Past research has supported a left hemisphere specialization for positive emotion [16 ,10, 47], language/verbal information [2, 20], behavioral activation and social approach behaviors [9] and parasympathetic activation [55, 56, 54, 17]. Conversely, past work investigating right-hemisphere function has suggested specialization for negative emotion [32, 44, 12, 7] nonverbal and spatial information [39, 54, 33, 19], affective/prosodic speech [23, 48], pain [40], behavioral inhibition and social avoidance behaviors [9], and sympathetic activation [13, 54, 6].

Lateralized frontal lobe pathology maintains similar distinctions between the left and right hemispheres. Left frontal pathology is associated with chronic fatigue and hypokinesis [38], social apathy and diminished happiness and humor with negative effects on social intelligence [8]. Conversely, right frontal pathology is more easily identified by social improprieties [49,42], impulsivity and

hyperkinesis [36] with negative effects on emotional intelligence [46]. This research has served to obstruct the performance of frontal lobotomies in the medical field. Nevertheless, the amotivational and/or apathetic pathology of a frontal lobe syndrome may still manifest in patients who experience traumatic brain injuries, severe infections, and other neurological complications. Like the historical accounts of the lobotomized patient, individuals may suffer from additional scrutiny and potentially following clinical efforts to assess using traditional measurement techniques, which may be somewhat resistant to these deficits. Here, we present the shared findings of independent and blind assessments of one gentleman across three medical center sites, yielding an overall diagnosis of frontal lobe syndrome, despite his superior performance on standardized tests and lack of formally acknowledged disability status.

A Case Study

The patient was a 62 year-old minister who had been involved in a pedestrian motor vehicle accident 4 years prior, in which he had suffered significant brain trauma and a left sided closed skull fracture. The magnetic resonance imaging (MRI) scans (Figures 1-3) provided evidence of traumatic brain injury (TBI) with bilateral inferior frontal lobe atrophy, in addition to small focal areas of encephalomalacia at the left temporal, occipital, and anterior parietal cortices. Following complaints of syncope episodes, the MRI revealed periventricular and subcortical white matter disease within the basal frontal regions. Of particular interest in this report is the traumatic insult to the frontal regions that specifically coincides with the rehabilitative trajectories of frontal lobotomies of the past.

The patient had a previous history of lumbar degenerative disk disease with L5-S1 left neuroforaminal stenosis. Otherwise, his medical history was unremarkable, apart from mild hearing loss and hypertension. He denied history of prior head injury; had
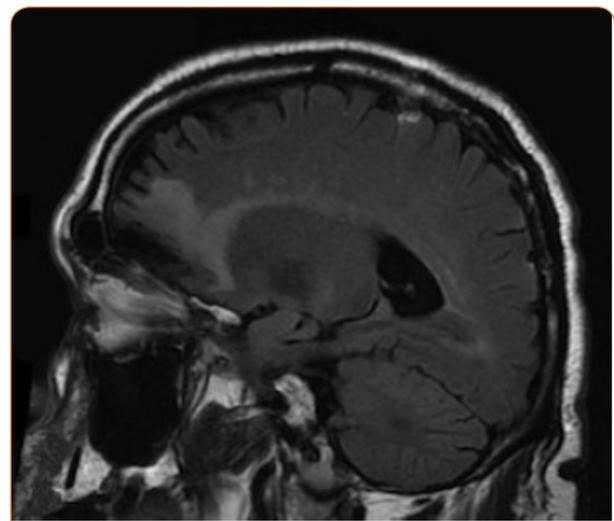

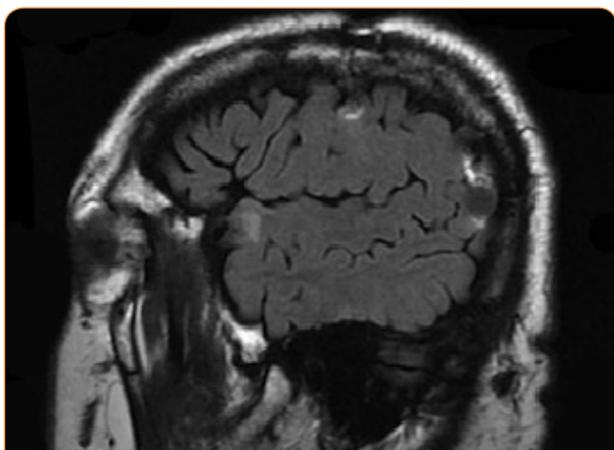**Figure 1.** MRI scan showing sagittal view of trauma to frontal regions.

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Figure 2. MRI scan showing sagittal view of focal lesions at left temporal, parietal and occipital locations.
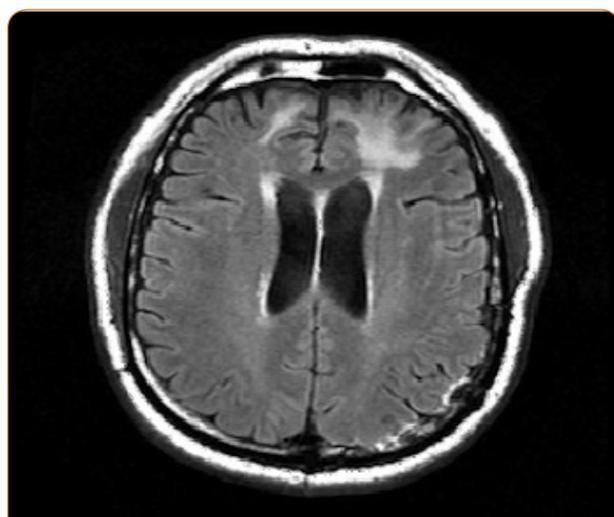

Figure 3. MRI scan showing horizontal view of trauma to bilateral frontal regions.

no formal psychiatric history prior to this incident; and was not previously administered any regular prescription medications. Following the accident, he was placed on Percocet, Dilantin, Zantac, and nebulizer treatments.

The extensive injuries he suffered were consistent with those that may result from a frontal lobotomy with affective and behavioral features clinically consistent with greater left frontal lobe pathology with amotivational and social apathy features. The encephalomalacia resulted in vocational complications as he was unable to complete routine duties and responsibilities at his parish and was placed on administrative leave. His marital relationship was described as increasingly distant and disengaged. The patient reported significant thought disturbances, depression, and paranoia, while family members noted considerable personality changes. Despite the severe intrusions in his daily activities and significant changes in his personal motivation, personality, and

interpersonal functioning after his accident, post-rehabilitative neuropsychological assessments failed to indicate any functional impairment. Indeed, his performance on these instruments was consistently above average.

Neurological And Neuropsychological Assessment: Across two separate evaluations at licensed medical facilities, the patient was administered a thorough battery of standardized assessments for intelligence and memory [Table 1]. When administered the Wechsler Adult Intelligence Scale [52], the patient achieved 'Superior' marks for each of the three measures of IQ (verbal, performance/nonverbal, and full scale). He also scored in the 'High Average' and 'Superior' score ranges for each subtest of the

Table 1: Interpretive Scores on Standardized Neuropsychological Tests of Memory and Intelligence

Neuropsychological Assessment	Score Range
WAIS-III	
Verbal IQ	Superior
Performance IO	Superior
Full Scale IQ	Superior
RBANS	Superior
Complex Figure Copy	Superior
Recall Complex Figure	100% Accurate
16 Word Recall	Superior
Word List Recognition	100% Accurate
Story Recall	92% Accurate
Digits Forward & Backwards	Very Superior
Spatial Span	Superior
Receptive Language	High Average
Expressive Language	High Average
Visual Naming	High Average
D-KEFS	
Trail Making	Average, High Average, Superior
Verbal Fluency Test	Superiora
Verbal Fluency Category	High Average
Spatial Spanning (Tower)	High Average
WMS-III	
Immediate Recall Story	Very Superior
Delayed Recall Story	Superior
Paired Associates	Very Superior
Delayed Paired Associates	Superior
Faces 1	Superior
Faces 2 (Delayed)	Average

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Repeatable Battery for the Assessment of Neuropsychological Status [43], used to evaluate overall neurocognitive status and cognitive decline in individuals who have suffered neurologic injury. When administered the Delis-Kaplan Executive Functioning System [11], an assessment of higher level executive functioning of the frontal lobes, the patient once again scored in the 'High Average' and 'Superior' range. Not surprisingly, the results of the Wechsler Memory Scale-III [53] further implicated his exceptional cognitive abilities, where he received 'Superior' and 'Very Superior' scores on five of the six subtests.

Despite the severe neurological trauma and debilitating changes in personality and behavior that this patient suffered, his post-rehabilitative scores on these measures failed to depict any abnormality or impairment in functioning. These findings were in stark contrast to the vocational disability where he was formally removal from his pastoral role and to the diminished effectiveness in his marital relationship. Although these standardized neurocognitive evaluations represent staples in the neuropsychologist's assessment arsenal, the need for more precise measures becomes very apparent when considering this patient's overall presentation.

The patient was referred for a third and final assessment in which a syndrome analysis was conducted. This neuropsychological assessment technique qualitatively inspects specific behaviors in a functional cerebral system to identify underlying pathology. Upon basic visual inspection, the patient presented with an unkempt and disheveled appearance, wearing ill-fit clothing and maintaining poor hygiene. He demonstrated a blunted or bland affect with a negative affect bias and perseveration on negative themes. The administration of the Geriatric Depression Scale (GDS) further supported moderate clinical levels of depression with complaints of emptiness, helplessness, lack of energy, and difficulty concentrating. The patient was amotivational and apathetic, with significantly diminished positive affect. He also demonstrated an absent gelastic response with sparse blink rate and masked facial expression. Further assessment showed additional difficulties with initiation and termination of social interactions, generally representing impairments of social pragmatics and social proprieties.

When inspecting olfactory systems, the patient presented with bilateral anosmia, consistent with ablations to the left and right olfactory mucosa (Figure 3). Evaluations of motor function showed bilateral facial dyspraxia, with diminished motor range of the corrugators and frontalis muscles. Exertion and/or cognitive stress in this patient resulted in poor respiratory regulation with bouts of dyspnea, possibly indicative of malfunction in the frontocerebellar systems. The patient experienced visual deficits, presenting with diplopia on lateral gaze and smooth pursuit to both the right and left sides with intermittent nonconvergent gaze. He maintained auditory receptive speech deficits, making multiple requests for repetition and complained of right sided paracusia and visual formesthesia. Additional speech and language complications consisted of diminished social approach with increased social avoidance and a diminished desire to converse with others. The patient's speech was variably halting, hesitant, and tremulous, but was coupled with mild expressive dysprosodia and poor volume regulation, thought to be clinically consistent with his frontal pathology.

Discussion

Neuropsychological treatment methods and assessment techniques used with frontal lobe pathology have improved over the last century. Nevertheless, this case provides evidence that the existing battery of standardized neuropsychological tests still maintains a large degree of imprecision and insensitivity to the diversity of frontal lobe syndromes. Modern research efforts continue to expand upon the range of functions that can be attributed to the frontal lobes, implicating this region in a much greater range of abilities than was previously understood. It is further demonstrated that the development of future neuropsychological measures might focus on maintaining greater sensitivity to the extensive range of frontal lobe functions and laterality differences. As evidenced in this case, individuals that experience significant frontal insult may subsequently develop amotivational or apathetic syndromes, experiencing debilitating changes in personality, motivation, and social behaviors. It is surprising that these same individuals are still capable of achieving exceptional scores on standardized neuropsychological tests of memory, attention, intelligence, and executive functioning, failing to reveal the true nature of their functional impairment.

With the acquisition of such unexpected findings, it is important to address the possibility of malingering or dissimilation efforts. Syndrome analysis, combined with the patient's high performance on the full battery of standardized assessment measures, provides evidence against the possibility for patient dissimilation. Nevertheless, the Test of Memory Malingering [51] was also administered during the third independent assessment to rule out the possibility of deception. The patient scored in the "Average" range, providing additional evidence against the possibility for patient dissimilation.

It has become apparent that individuals who experience significant frontal lobe injury may still evidence preserved memory function and intelligence. Thus, it may become exceedingly difficult for both the clinician and the layperson to appreciate the true disability in these individuals. Their diminished energy levels and reduced intent/desire to engage socially, or in verbally interactive activities, may subsequently lead the clinician to make inaccurate personal attributions regarding the patients' intentionality. Results from standardized tests in current neuropsychological evaluations will not reflect the true disability that these individuals sustain in regards to social behaviors and motivation. It has become necessary for the clinician to supplement modern standardized test measures with more creative assessment techniques in order to accurately evaluate the scope of lateralized frontal lobe syndromes.

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The present findings are reminiscent of earlier accounts of "threshold theory" [45], where standardized testing provides for comparison of the individual patient's performance and abilities relative to a normative sample of the broader population with similar demographics (e.g., age and sex). The normalized distribution in these comparisons remains subject to extreme variants for any individual place against these norms. For example, an intellectually superior individual may suffer significant loss to fall only within the "average range" within the distribution subsequent to the brain injury. But, beyond this argument is the clear need for increasing sensitivity to specific frontal lobe syndromes. The development of the Weschler Memory Scale-IV (WMS-IV), for example, has been criticized for the focus on psychometric integrity over neuroscience based evidence [35]. This approach does little to provide a benefit to the field drawn from the substantial advances in clinical neuroscience in the understanding of functional cerebral systems and may direct initiatives instead towards the test itself as we try to understand what it measures.

Some of the defining features common to traumatic brain injuries include irritability, poor emotional regulation, and depression. These may be more readily appreciated with sports related traumatic brain injury. Duma [15] placed force transducers in helmets worn by football players and recorded contacts with other players sometimes measuring over 100 Gs. It appears reasonable that the potential exists for as many as 2000 such concussive blows to the helmet (and presumable the head and brain), during the player's career. These findings indicate that traumatic brain injury may represent a likely rather than an improbable event for the players. Many clinicians and many of those within neuroscience have held onto mythical views towards head injury, including the notion that it requires a loss of consciousness or at least an altered level of consciousness; that the location of the injury is restricted to the area of impact to the head; and that these injuries are restricted in time to the event and a subsequent recovery period extending across a six month window. Further, the strict and exclusive reliance on standardized comparisons of test scores produced by the individual with group norms may be inadequate or misleading with frontal injury (the present case). Moreover, head injury may render the individual subject to active and potentially progressive decline which, in some cases, may only be appreciated later in life.Many individuals diagnosed with "Alzheimer's," "dementia,", and even Lou Gehrig's disease [27] are notable for their distinct history of prior head trauma [34]. The physical forces, rather than focal impact at the point of contact, may be substantially more displaced affecting the integrity of diffuse, far field, and generalized brain systems. These changes may be evident in diffuse axonal injury and dendritic damage arising from torsion, stretching, and shearing forces. The injury may be aggravated by subsequent edema or swelling of the brain tissues, compression of the fluid containing spaces, and alteration of the circulation of cerebrospinal fluid, vascular dynamics, and ischemic events.

The secondary consequences of head injury surely include, for some, the loss of established relationships (e.g., with their spouse or significant other and employer), and negative impact upon employment or career advancement. These aspects of traumatic brain injury are substantial with a long history of generally poor appreciation by society at large. This is perhaps more evident in the development of awareness for the residual and the progressive features of traumatic head injuries within the National Football League [28, 37, 4]. For many though, and perhaps for the majority of those with traumatic brain injury, a good recovery and return to a previous lifestyle may be anticipated, through a gradual restoration of normal brain functions and processes.

Military conflicts across the globe have deepened the crisis in traumatic brain injury management and treatment and neuropsychological services are often in high demand within the Veterans Administration Medical Centers across the country. Current and recent military conflicts have seen the effective use of improvised explosive devices or "IEDs" as weapons frequently used by combatants and terrorists [14, 26]. Indeed, blast-induced traumatic brain injury has become the "signature wound of the war on terror" [5]. Gupta & Przekwas [26] note, in their review of the literature that twenty percent of service members or 320,000 of the deployed force potentially suffer from traumatic brain injury [50]. It is relevant that blast injuries were found to account for about seventy percent of the wounded service members' injuries. About eighty percent of these were classified as mild traumatic brain injuries, with penetrating or severe head injuries accounting for some 2.8 percent of the wounds. Although the majority of mild traumatic brain injury cases are expected to recover, persistent symptoms are to be expected after injury, including chronic dizziness, fatigue, headaches, and impaired memory or cognition [31].

Beyond the apparent risks from contact sports and soccer, half of all traumatic brain injuries arise from accidents involving automobiles, motorcycles, bicycles, and pedestrians [1]. Traumatic brain injury remains the leading cause of death and disability in children and young adults in the United States. In those individuals 75 years of age and older, the majority of head injuries are caused by falls. Some twenty percent of traumatic brain injuries are due to violence, including child abuse and gun shots. About three percent arise secondary to sports-related injuries.

The defining criteria for the diagnosis of traumatic brain injury are derived from evidence of neuropsychological deficits following the assessment of learning and memory, executive functions, and the identification or exclusion of specific neuropsychological syndromes discussed elsewhere in this book. Even mild concussive injury may result in permanent brain damage. Thus, the diagnosis of head injury is one which identifies an active and potentially progressive disorder, often requiring follow-up evaluation on a yearly basis not to exceed a five year interval.

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Although these guidelines are crude, they have served many individuals over the years and provide an ongoing interface between the patient and their healthcare providers. These relationships may be useful in their implied role for monitoring and detection. They may also prove useful in supportive care and referral, including the treatment of depressive disorders and the provision of counseling, if needed. Clearly, the resources extend beyond these professionals and more importantly to the caregiver and to community resources for those with head injury, including the Brain Injury Society active in many communities and on the worldwide web.

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