



Case Report

Uses and abuses of the neuropsychological assessment in the presurgical evaluation of epilepsy surgery candidates



Sallie Baxendale*, Gus A. Baker

Department of Psychiatry/Division of Neuropsychology, University College London, London, UK

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ABSTRACT

Recent guidelines from the International League Against Epilepsy (ILAE) delineating the role of the neuropsychologist in the assessment of epilepsy surgery patients stress the collaborative contribution neuropsychologists should make to seizure characterization, lateralization and localization in the presurgical setting. The role they should play in the comprehensive counselling of surgical candidates, including exploration of the patient's expectations of surgical treatment is also mandated. In this paper we present two contrasting case studies which illustrate the importance of these roles and the impact they can have on patient outcomes. In Case A we describe the patient journey of a 69-year-old woman with left hippocampal sclerosis and concordant neurophysiology and seizure semiology. We present the series of discussions and decisions which led her to reject the surgical option following a detailed exploration of her motivations for surgery and the likely cognitive consequences of the procedure. In Case B we describe the series of errors and omissions which led to the failure of a clinical team to correctly interpret and integrate neuropsychological findings into the larger clinical picture of a 19-year-old woman with a seven year history of seizures. These errors ultimately culminated in the patient undergoing a right temporal lobe resection to treat psychogenic nonepileptic seizures (PNES).

The extent of integration of the data from the clinical neuropsychological assessment in the full presurgical evaluation was critical in determining the outcomes in both of these cases. Surgery did not solve Case B's problems and left her with the lifelong cognitive vulnerabilities that are associated with unilateral temporal lobe resection. In contrast, Case A was a good surgical candidate, but comprehensive integration of the neuropsychological findings into the larger clinical picture established that surgery was not the best solution to the problem she wished to solve.

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1. Introduction

The role of the neuropsychological assessment in the presurgical evaluation of epilepsy surgery candidates has developed over time. Historically the scores from neuropsychological tests were primarily used for lateralising and localising a possible seizure focus in potential candidates for epilepsy surgery primarily using the material specific model of memory function [1,2]. In modern surgical programs the role of neuropsychology has expanded significantly beyond the provision of a soft sign of hemispheric or lobular dysfunction [1,3]. The current International League Against Epilepsy (ILAE) guidance lists four key expectations for a neuropsychological assessment in epilepsy surgery [3]. See Table 1.

* Corresponding author at: ESRC Epilepsy Society, Chesham Lane, Chalfont St Peter, Buckinghamshire SL9 0RJ, UK.

E-mail address: s.baxendale@ucl.ac.uk (S. Baxendale).

In this narrative review we present the outcomes of two contrasting surgical candidates where neuropsychology played a pivotal role in the surgical pathway, to illustrate the ways in which the results from a neuropsychological assessment can be used and abused in the surgical setting.

1.1. Case A.

1.1.1. Clinical history

Case A was a 69-year-old, right handed, retired family doctor (general practitioner) when she was referred to The National Hospital for Neurology and Neurosurgery in London for a presurgical assessment. She had developed focal impaired awareness seizures with loss of awareness in her mid 40s which were fully controlled on two anti-seizure medications and she returned to driving for two decades until she experienced a further seizure whilst at the wheel of her car, aged 63. She sustained major orthopaedic injuries in the resulting road traffic accident, but no

Table 1
2019 ILAE Indications and Expectations of A Neuropsychological Assessment in Epilepsy Surgery.

To establish a baseline against which change can be measured following surgery
To provide a collaborative contribution to seizure characterization, lateralization and localization
To provide evidence-based predictions of cognitive risk associated with the proposed surgery
To provide the evidence base for comprehensive preoperative counselling, including exploration of patient expectations of surgical treatment.

significant head injury. Her seizures returned on a weekly basis and she did not regain seizure control despite trials of multiple antiseizure medications. At the time of referral for surgery she was taking carbamazepine, levetiracetam and gabapentin and was experiencing 2–3 seizures a week where she would stare blankly and would become unresponsive with manual automatisms. Her family reported that she would sometimes speak gibberish during the attacks which lasted 2–3 minutes before she rapidly recovered.

1.1.2. Pre-surgical investigations

An MRI revealed normal age-related changes and a small left hippocampus, with a loss of internal architecture and increased T2 signal. Overall the appearances were consistent with left hippocampal sclerosis with a R:L volume ratio of 77%.

Interictal EEG demonstrated intermittent rhythmic slowing in the left temporal lobe.

A 5-day video telemetry study captured three focal seizures with a loss of awareness, which were confirmed by a family member as representative of her habitual events. Ictal semiology and EEG changes during both seizures were both consistent with a dominant, left mesial temporal lobe onset, with some dysphasia and difficulties in naming objects evident in the immediate post ictal phase.

Her neuropsychological assessment revealed intellectual function in the upper average range, consistent with her reading ability and educational and occupational history function (WAIS-IV Verbal Comprehension Index 112, Perceptual Reasoning Index 117, Working Memory Index 108, Processing Speed Index 117). On tests involving the learning and recall of verbal material [4] her scores generally fell in the above average range and in line with expectations given her general level of function. Similarly on analogous tasks involving visual material, no deficits in non-verbal memory were recorded. Her expressive and receptive language skills were assessed to be intact. See Table 1.

She performed well on a test of verbal fluency and did not report elevated levels of anxiety or depression on the Hospital Anxiety and Depression Scale HADS [5]. In short, this was a normal neuropsychological profile, which was consistent with her subjective experience. While she reported some word finding difficulties in everyday life, she did not think that these were greater than those of her peers and attributed them to normal aging. She did not have any significant cognitive complaints with respect to her everyday function.

1.1.3. Multi disciplinary team discussion

At the multidisciplinary team (MDT) discussion, the team agreed that Case A appeared to be a good surgical candidate in many respects, with a clear, easily resectable lesion on her MRI and concordant ictal semiology and neurophysiology. Although older than the typical surgical candidate, she was in good health physically and there were no significant concerns about her ability to withstand surgery from a physical perspective. She did not experience focal to bilateral tonic clonic seizures which would confer an increased risk of SUDEP without surgery. However her intact neuropsychological profile was a concern. Her age and

intact memory function placed her at high risk of a significant post-operative memory decline. She had no experience of living with memory difficulties and at the time of the pre-surgical evaluation had no subjective complaints with respect to her day-to-day function. It was agreed that the neuropsychologist should meet with her to explain the likely cognitive consequences of the proposed surgery [6].

Neuropsychological input; the role of comprehensive preoperative counselling

There were three key strands to the pre-surgical counselling in this case. First, the results of the neuropsychological assessment were fed back and the likely impact of the surgery on her post operative function in each cognitive domain was explored. Secondly the likely impact of these anticipated changes on practical aspects of her life was examined and the possibilities and limitations of compensatory strategies were explored using the prehab model of rehabilitation [7]. However it was the third strand of the discussion that proved decisive in Case A's surgical pathway; the exploration of her motivations for and expectations of surgery. Case A had lived and worked with epilepsy for a number of years before seeking surgery. Unusually she started to investigate the possibility of surgery when she retired from medical practice. In the counselling session she admitted that the overriding incentive for her seeking surgery was to be able to return to driving. She lived in a rural location with poor public transport links and wanted to drive to keep in contact with her family, now that she was retired. When asked if she would pursue surgery if she had an unlimited taxi account she was clear that this would solve the problem, and what's more it would solve the issue without any risk to her cognitive function. By carefully exploring her motivations for surgery it was clear that a brain resection was just one, high risk solution to the actual problem she wanted to solve, the social restrictions associated with the inability to drive. Surgery carried a high risk of noticeable memory decline and the outcome was not guaranteed to allow a return to driving. There was a one in three chance that her seizures would continue and a further possibility of a visual field defect that could preclude a return to driving even if her seizures were controlled. In the best-case scenario, she would be able to return to driving 12 months after the surgery.

Case A was offered surgery with a 60–70% chance of seizure freedom. On the basis of the statistical algorithms we use to predict postoperative outcome [8] we estimated that Case A had a greater than 50% possibility of experiencing a significant decline in verbal memory function; a decline which would be expected to have some impact on her day-to-day function. Her age and good preoperative function, with much to lose were highlighted as significant variables contributing to this risk. Case A did not experience focal to bilateral tonic-clonic seizures which would infer an increased risk of sudden unexpected death in epilepsy (SUDEP), but the patient was aware of risks of SUDEP with ongoing seizures. After carefully considering the risks, benefits and cognitive costs of the procedure in relation to the goals she hoped to achieve, she declined to proceed to surgery.

1.2. Case B.

1.2.1. Clinical history

Case B came to the attention of one of the authors (GB) when he was asked to provide an expert medicolegal opinion on her care by the UK Court. The case was brought to the UK court by the patient in a claim for medical negligence. Her clinical care was provided by outside clinicians.

Case B was as diagnosed with epilepsy at the age of 12 years and was referred for a presurgical assessment at the age of 19. She was a right-handed, unemployed woman who had been prescribed a combination of antiseizure medications without any evidence of remission. At the time of referral she was experiencing what were described in the court records as 'generalized seizures' which occurred without warning. Her family reported that during these attacks she would be unconscious for anything between 2 and 10 minutes and each event was followed by a period of confusion and sleepiness. Case B and her family were very keen for her to undergo elective surgery.

1.2.2. Pre-surgical investigations

No abnormalities were identified on her MRI by the treating team or the medicolegal experts who subsequently reviewed the images in the court proceedings. Interictal EEG demonstrated intermittent rhythmic slow in the right temporal lobe. No video-EEG recordings of her seizures were recorded. Her neuropsychological assessment revealed intellectual function in the low average range, consistent with her reading ability and educational and occupational history function (WAIS-IV Verbal Comprehension Index 85, Perceptual Reasoning Index 90, Working Memory Index 76, Processing Speed Index = 73). On the Wechsler Memory Scales, there was a 12-point difference in favor of her non-verbal memory (Index Score 92) when compared to her verbal memory (Index Score 80). See [Table 1](#). Her expressive and receptive language skills were assessed to be intact. She reported elevated levels of anxiety and depression on the Hospital Anxiety and Depression Scale (HADS) at the time of her neuropsychological assessment.

The clinical psychologist who conducted the assessment concluded that Case B's neuropsychological profile was 'consistent with the interictal EEG' and that it indicated right temporal dysfunction. No reference was made in the neuropsychological report to the large volume of medical records, a 12-year history of unexplained medical symptoms and the negative results of consequent investigations. No mention was made of her family background or the possible relevance of her elevated levels of anxiety and depression on her presentation.

1.2.3. Multi disciplinary team discussion

There were no records relating to a multidisciplinary team (MDT) discussion in this case.

1.2.4. Surgical treatment

On the basis of her medical history, neurophysiological investigations and cognitive assessment, Case B was considered to be a candidate for epilepsy surgery. The claimant underwent a standardised right temporal lobe resection but continued to have seizures. Several months later the claimant was seen by an epileptologist who undertook a substantial review of her medical records and investigations and concluded that the claimant was unlikely to have ever suffered from seizures and that a more definitive diagnosis was psychogenic nonepileptic seizures (PNES) Case B's family proceeded with a legal claim of medical negligence against the hospital that carried out the surgery.

There are two aspects of the neuropsychological input in this case which deserve discussion. First, the neuropsychologist's interpretation the test scores was incorrect. Second, even if the neu-

ropsychology had suggested right temporal lobe dysfunction, this would not be enough evidence to offer surgery in the absence of a consistent clinical picture that indicated that the patient had right temporal lobe epilepsy and that this was amenable to surgery. Before a diagnosis of epilepsy had even been confirmed, the surgeon put too much weight on the neuropsychology and the interictal EEG abnormalities as firm signs of lateralisation, Neuropsychological scores are at best a soft sign in isolation, but must be considered in the light of a complete clinical picture in a multidisciplinary evaluation.

This case illustrates:

- 1 The need for thorough pre-surgical investigation particularly in the context of a history of unexplained symptoms.
- 2 The failure to consider a differential diagnosis of PNES [\[9,10\]](#)
- 3 The substandard pre-surgical neuropsychological assessment and the misinterpretation of the test results.
- 4 The non-existence of a multidisciplinary team input.

2. Discussion

These two cases provide a dramatic illustration of the critical role that integration plays when it comes to the consideration of neuropsychological scores in the evaluation of epilepsy surgical candidates.

Case B was not just a poor surgical candidate, she was not a candidate for epilepsy surgery at all, since she did not have epilepsy. Her imaging was normal and no ictal EEG studies were obtained in contravention of the current guidelines for the preoperative evaluation of epilepsy surgery candidates [\[11\]](#). She had a long history of medically unexplained symptoms. In retrospect there were enough clues in her medical records to suggest a diagnosis of PNES to convince a Court of this probable diagnosis. A decision to offer surgery was made on the basis of intermittent right temporal slowing on an interictal EEG recording and apparently concordant neuropsychology. It is undoubtedly noteworthy that the neuropsychologist's assertion that a relative impairment in verbal memory was consistent with the interictal EEG abnormality in the right temporal lobe. This would not be consistent with the material specific model of memory function that was prevalent at the time [\[2\]](#). In actual fact her verbal memory abilities were broadly consistent with her verbal intellectual functions, whilst her visual memory functions were consistent with her non verbal reasoning skills. Whilst her profile suggested relative strengths in functions traditionally associated with non-dominant hemisphere function, none of her scores indicated any significant degree of cognitive impairment. In the absence of any evidence of cross lateralisation in this right-handed patient (no Wada test or fMRI studies were undertaken) her profile would indicate that her non dominant hemisphere functions were stronger than her verbal abilities. Whilst patients with non-dominant temporal lobe dysfunction can demonstrate difficulties in verbal learning, this is typically seen in the context of more widespread memory disturbance. The treating neuropsychologist was incorrect in labelling this profile as consistent with a right (presumably non-dominant) temporal lobe focus.

However, the error in this case was the failure to integrate these cognitive findings with the complete clinical picture. Even if Case B's cognitive profile had been reversed and it had indicated relatively weak visual memory functions, this would not be strong enough evidence for a team to confidently lateralise a seizure focus. Given the multitude of factors that influence neuropsychological test scores [\[1\]](#) the fundamental error in this case was the attempt to use a neuropsychological profile as a definitive, standalone index of lateralisation. Even a rudimentary attempt to embed these findings in the broader psychological picture of

longstanding psychological distress, likely somatisation and the levels of psychiatric disturbance evident at the time of the assessment may have led to a very different outcome for this patient. As it was, the failure to integrate the neuropsychological findings with the whole clinical picture contributed to Case B being left with an untreated PNES and a lifelong reduction in cognitive reserve associated with the resection of normal mesial temporal lobe structures.

Unlike Case B, Case A had a clear, surgically amenable lesion evident on her MRI and her extensive neurophysiological evaluations were all concordant with left hippocampal sclerosis, suggesting that this abnormality was responsible for her seizures. There were no neuropsychiatric concerns. In many respects Case A was the ideal straightforward, surgical candidate, with a picture of clear concordance that is becoming increasingly rare in many surgical centres in the 2020's. However, it was the integration of her neuropsychological profile into the full clinical picture that ultimately resulted in Case A not pursuing the surgical option. Her intact neuropsychological profile indicated that she would be at high risk of a significant postoperative decline in memory function. Clinical intuition born out in a number of studies of postoperative outcome, dictates that it is those who have function to lose who are most likely to lose it [12,13]. Case A's age was also an important factor in the consideration of her likely postoperative outcome. In addition to high scores on memory tests prior to surgery, predictive models of postoperative cognitive decline have also identified older age as a significant risk factor for postoperative decline [12–15]. Guided by the neuropsychologist, an examination of the likely cognitive 'cost' of the surgery balanced against the risks and benefits, led Case A to explore other alternatives to achieve her goal, which in this case was not to be seizure free but to regain the freedoms associated with driving. Further work with the neuropsychologists created a solution to this problem with zero cognitive risk.

The integration of the data from the clinical neuropsychological assessment was critical in determining the outcomes in both of these cases. Surgery did not solve Case B's problems and left her with the lifelong vulnerabilities that are associated with unilateral temporal lobe resection [16]. In contrast, Case A was a good surgical candidate, but once again, surgery was not the best answer to the problem she wished to solve. We have much to learn from both cases.

The cumulative errors that resulted in surgery for Case B are fundamental and highlight the potential risks involved in the "dispersion" of epilepsy surgery to sites with less experience/expertise. Case A was assessed in an academic epilepsy surgery center, which typically adopts a very proactive approach to challenging cases, yet for Case A, surgery was bypassed. This interesting dissociation highlights the critical importance of the multidisciplinary approach in the evaluation of epilepsy surgery candidates.

It is possible that Case B and her family's strong desire for surgery influenced the clinical decision making in this case. This highlights the necessity of including a full discussion of the role that seizures play in someone's life and their expectations of seizure freedom, as part of the preoperative evaluation. Counselling with respect to desires versus realistic expectations is critical in this regard [17].

The role of neuropsychology in the presurgical assessment will continue to evolve in response to the remarkable and relentless developments in the field; from advances in the classification and conceptualization of epilepsy, seizures and their underlying pathology [18,19] to the development of new technologies and techniques in imaging and electrophysiological recordings [20–22]. Integration of these new techniques with traditional measures of neuropsychological function is critical to ensure we fully understand the impact of any proposed surgery on each potential surgi-

cal candidate. Collaborative interpretation remains the key to ensuring an optimal outcome for every patient on the surgical pathway. **Table 1:** Summary of Neuropsychological Test Scores for Case A & Case B

	Case A	Case B
Wechsler Adult Intelligence Scales (IV)*		
Verbal Comprehension Index	112	85
Perceptual Reasoning Index	117	90
Working Memory Index	108	76
Processing Speed Index	117	73
Wechsler Memory Scales*		
Auditory Memory Index	-	80
Visual Memory Index	-	92
BMIB**		
Prose Recall Delayed	50th – 75th	-
List Learning	75th – 90th	-
Design Learning	90th	-

* Standardised scores (mean = 100, s.d. = 15)

** Percentile range

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Ethical Statement

This paper presents two case studies. All personal Identifying information (including names, initials, hospital numbers and photographs) have been stripped from the manuscript. Nonessential identifying details have been omitted in line with the ICMJE recommendations. The individuals described in this paper cannot be identified from the information provided.

Declaration of Competing Interest

Prof Baker received a fee as an expert witness in the medicolegal case brought by Case B following her surgery. Dr Baxendale has no conflicts of interest to declare.

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