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Self-awareness and underestimation of cognitive abilities in patients with adult temporal lobe epilepsy after surgical treatment

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ABSTRACT

Introduction: Self-awareness of cognitive, emotional, functional, and social performance is critical for compliance with treatment. However, few studies have investigated self-awareness and the associated effects on other cognitive variables in patients with temporal lobe epilepsy (TLE) after surgical treatment.
Aim: This study was designed to investigate the prevalence of impaired self-awareness (ISA) in patients with TLE who have undergone surgical treatment. Associated correlations with clinical variables (frequency of seizures before surgery, time elapsed since the epilepsy diagnosis, depression, and anxiety) and verbal and visual episodic memory function and differences between patients with right and left TLE were also investigated.
Method: Twenty-three adults with TLE after surgical treatment were assessed with the Patient Competency Rating Scale (PCRS-R-BR), the Rey Auditory Verbal Learning Task (RAVLT), and the Modified Ruche Visuospatial Learning Test (RUCHE-M). Patients were considered to have memory dysfunction if delayed recall as assessed with the RUCHE-M or RAVLT was at or below the 25th percentile. Patients were considered to have ISA if PCRS-R-BR discrepancy scores were at or above the 75th percentile. Underestimated cognitive ability (UCA) was defined as a PCRS-R-BR discrepancy percentile score ≤25. Results were analyzed using frequency, Spearman correlation, regression analyses, and the Mann–Whitney test.
Results: Frequency analysis of the total sample indicated ISA in 39.13% of patients ($n = 9$), UCA in 39.13% of patients ($n = 9$), and impaired verbal and/or visual memory performance in 69.56% of patients ($n = 16$). Moderate positive correlations were found between the frequency of seizures before surgical treatment and relatives' reports, as well as between the duration of time that had elapsed since the epilepsy diagnosis and patient reports. Negative and moderate correlations were found between the frequency of seizures and the discrepancy score, as well as between depression and patient reports. No differences in PCRS-R-BR were found between patients with right vs. left TLE. No clinical variables significantly predicted self-report or self-awareness.
Conclusion: Patients with TLE exhibit various patterns of ISA and negative effects on cognitive function after surgical treatment. Emotional factors and relatives' reports must be considered when assessing these patients.

1. Introduction

Epilepsy is a neurological disease considered highly prevalent worldwide, affecting 50 million people; 80% living in developing countries. Temporal lobe epilepsy (TLE) is the most common type of epilepsy, and it is associated with a wide range of cognitive impairments, especially episodic memory and language, and a decreased quality of life [1–3]. Medically refractory epilepsy is defined as the persistence of seizure despite two consecutive attempts at treatment with different first-line antiepileptic medications. The severity of refractory TLE is evaluated to identify good candidates for surgery. A good presurgical assessment helps to identify those individuals who may achieve excellent postsurgical seizure outcomes. However, despite improvements in seizure control, quality of life, and cognitive function, cognitive deficits (especially related to memory) commonly persist [2,4]. Few studies have investigated the optimal approach to neuropsychological rehabilitation in this patient population [5]. Also, there is little information in the scientific literature pertaining to the compliance of patients with TLE with efforts at rehabilitation. Based on an extensive literature on self-awareness and rehabilitation compliance in brain disorders [6–9], we hypothesized that one characteristic that could be used to identify patients likely to benefit

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from efforts at rehabilitation would be self-awareness related to cognitive deficits [10]. Related studies are scarce.

Self-awareness refers to the ability of an individual to fully experience and perceive his personal functions [11–13]. Self-awareness is considered a major feature of neuropsychological assessment because it impacts the patient's ability to report cognitive, motor, emotional, and/or functional impairments. Impaired self-awareness (ISA) has implications for compliance with neuropsychological rehabilitation and community integration [14]. In the context of neurological disorders, anosognosia is completely impaired perception of the individual's own level of neurological or neuropsychological function, despite clear evidence of impairment [13,15].

While current literature has addressed deficits in self-awareness in various clinical populations, such as traumatic brain injury [16] and stroke [17], few studies have investigated this condition in TLE. Galioto, Thamilavel, Blum, and Tremont [18] found that in a sample of adult patients with epilepsy (48.4% with TLE; 51.6% of idiopathic origin) assessed with the Cognitive Difficulties Scale, more than a quarter (29%) showed a decline in self-awareness; overestimating their performance on cognitive tasks. The authors found a positive and moderate correlation between patients and relatives report about cognitive functioning; however, no correlations were found between the discrepancy score and cognitive function performance. In a subgroup of patients with subclinical impairment in attention/executive function, discrepancy score showed positive and moderate correlations with delayed memory recall. These results indicate that patients with epilepsy can have impairment in self-awareness of deficits, and this may be associated with a worse delayed memory performance.

Another study [19] with a sample of patients diagnosed with epilepsy of different etiologies (ages 14–70) found that 61% of the sample showed fair, scarce, or no concordance between cognitive scores and self-report by The Multiple Ability Self-Report Questionnaire. In this subsample, 47% showed overestimation of cognitive abilities, while 53% underestimated cognitive abilities. Patients that overestimated their capacities were older, less educated and had a worst cognitive performance when compared with patients that underestimated their abilities. However, overestimation and underestimation groups were not different on depression, anxiety, and epilepsy clinical variables. Together, these results indicated that awareness difficulties in epilepsy can be as common as in other neurological disorders.

Finally, in a another study [20], the Patient Competency Rating Scale (PCRS) was administered to a population of epileptic veterans ($n = 117$) and veterans with nonepileptic psychogenic seizures ($n = 131$) in order to measure and address differences in cognitive, emotional, interpersonal, and daily tasks. The results showed that patients with psychogenic seizures reported more deficits in all areas than the epileptic veterans. This result was especially strong in the emotional domain. In this scenario, so far, no studies have investigated self-awareness of cognitive functioning in adults with TLE after surgical treatment comparing patients with their relatives' reports.

Mood relates more to self-perception of cognitive functioning than actual cognitive performance in several diseases and in normal samples. As an example, memory self-rating decline in healthy elderly (60 to 90 years of age) has been related to worst affective state and objective memory performance [21]. Similar findings have been described in other studies. In a study with elderly six weeks after coronary artery bypass grafting surgery, perceived cognitive difficulties were not correlated to objective measures of cognitive functioning, but with higher levels of depression and anxiety [22]. In a sample of 221 patients with multiple sclerosis, depression, anxiety, fatigue, and level of disability were associated with worse self-perception of cognitive functioning [23]. In parallel, the presence of anxiety and depression symptoms also have an impact on objective cognitive performance of memory and attention [21,24]. However, the presence of lack of self-awareness has been related to apathy and low anxiety symptoms in mild Alzheimer's disease [25] and less depression and behavioral disinhibition in multiple sclerosis [26]. These findings have implications for clinical practice. Patient's concerns or complaints of cognitive problems must be interpreted with caution, since anxiety and depression seem to play an important role in patient's self-evaluation. Other sources of information and objective measures must be considered in clinical evaluation.

Studies of adults with epilepsy have indicated that more memory complaints are associated with depression/anxiety symptoms [27–34], while other variables such as seizure type [27], type of epilepsy [30], and epilepsy duration [28,30] show no relationship with memory complaints. The direction of associations between memory complaints with seizure frequency [28,35], age at epilepsy onset [27,28,32], lateralization of epileptic focus [36–38], and number of antiepileptic medications [27,28,35,39] seems inconsistent across studies. A multiple regression analysis with 138 patients with epilepsy indicated mood alone ($R^2 = 0.56$) explained subjective memory performance in a similar way when compared with mood and objective performance combined ($R^2 = 0.58$) [29], while another study indicated anxiety explained 17% and memory performance 8% of variance of subjective memory complaints in patients with epilepsy [32]. At the same time, no statistically significant correlations were observed between depression and objective memory performance [29,31,33]. Self-report of memory difficulties seems to be associated with impaired memory performance in epilepsy [28], although some studies indicate low correlations between these variables [29,31]. Taken together, these findings indicate the importance of including measures of objective memory performance, self-perception, and mood in clinical assessment of patients with epilepsy, since these variables interact and at the same time can be dissociated.

Of special interest for the present study, Sawrie et al. [39] investigated subjective and objective memory change in a sample of 64 patients with left or right anterior TLE who underwent surgical treatment. Authors found that measures of objective and subjective memory change did not show significant correlations. In addition, only 3 to 5% of patients reported subjective memory decline after 1 year after surgical treatment, while 26 to 55% had objective memory decline. Self-report of memory decline seemed to be predicted by emotional distress in this period after surgical treatment. In conclusion, findings indicated subjective memory decline after surgical treatment after anterior temporal lobectomy (ATL) could be a sign of mood disorder.

Therefore, this study aimed to verify the frequency in which patients with TLE who had undergone surgical treatment show ISA or underestimation of cognitive abilities while using PCRS-R-BR Discrepancy score. Besides, analyses of self-awareness profiles and objective measures of performance on tasks related to episodic memory will be presented, as well as its associations with clinical characteristics, such as frequency of seizures before surgery, time elapsed since the epilepsy diagnosis, lesion laterality, depression, and anxiety.

2. Methods

2.1. Participants

Adult patients diagnosed with epilepsy ($n = 23$) ranging in age from 18 to 58 years and their relatives were assessed as part of a clinical investigation. The patients were in an Epilepsy Center in the Paulo Niemeyer State Brain Institute during the years 2018–2019. The study was conducted according the principles of the Declaration of Helsinki and approved by the ethics committee of the Paulo Niemeyer State Brain Institute (CAAE 70807617.0.0000.8110). The Paulo Niemeyer State Brain Institute is a tertiary care center for patients with epilepsies of different etiologies, where patients undergo a complete assessment for epilepsy surgery candidacy. All patients responded to the study questionnaires after surgery. Relatives were mothers (39.1%), spouses (34.8%), siblings (8.7%), fathers (4.3%), sons/daughters (4.3%), grandparents (4.3%), and cousins (4.3%) with mean years of age 51.52 (standard deviation (SD): 17.9) and years of education 11.61 (SD: 4.42). Patients were excluded if they had borderline or lower intelligence (Wechsler Abbreviated Intelligence Scale (WASI) IQ ≤ 70) [40] or if they had a history of severe psychiatric disorder, such as bipolar disease, obsessive–compulsive disorder, schizophrenia, or personality disorders. All patients answered the Hospital Anxiety and Depression Scale – Anxiety and Depression (HADS) (cutoff score > 8 for probable disorder) [41]. Sociodemographic and clinical data from patients with TLE are presented in Table 1.

2.2. Instruments

2.2.1. Patient Competency Rating Scale (PCRS-R-BR) [42,43]

While the original PCRS contained 30 items, the version used for this study includes only 17 items that assess mostly cognitive functioning. So far, it has been adapted (translations and back translations; item analysis by authors; classification by experts; revisions and reformulations by authors) and validated (content-based and external validity), and normative studies are published for use in Brazilian Portuguese in the treatment of patients with traumatic brain injury [43–45]. The 17 items chosen for inclusion assess cognitive function, such as executive functions, episodic and prospective memory, activities of daily living, emotions, theory of mind, and sustained attention. As in the original version, the PCRS-R-BR includes specific versions for patients and for relatives/clinicians, respectively. Self-awareness is assessed by measuring the discrepancy in score between the patient and relative/clinician versions. Participants are asked to quantify their difficulty in performing various tasks on a Likert scale ranging from 17 to 85, with higher scores indicating less difficulty. Questionnaires were administered individually by a clinical neuropsychologist. No additional instructions were provided.

2.2.2. Rey Auditory-Verbal Learning Test (RAVLT) [46,47]

This classical paradigm is used to evaluate verbal episodic memory through word lists. List A is repeated five times (essays A1, A2, A3, A4, A5). List B is then presented once (B1), followed by spontaneous retrieval of list A by the participant. After 20 min, individuals are encouraged to spontaneously retrieve list A. Immediately after this attempt at retrieval, a recognition task is administered. The recognition task utilizes 50 words from lists A and B, as well as distractors. Individuals must recognize the words from list A.

2.3. Modified Ruche Visuospatial Learning Test (RUCHE-M) [48–50]

This task is a visuospatial form of the RAVLT. The participant must memorize the location of 10 black squares in a matrix of 41 empty squares. The task includes a perception essay (copy task), five learning trials (A1 to A5), an interference trial (B1), an immediate recall trial of the original model (A6), a trial assessing delayed recall after 20 min, and a recognition trial (REC) in which the original model must be selected. A psychometric study of RUCHE-M with a healthy sample indicated adequate content and construct validity [48]. This task has been utilized to assess visual episodic memory in neurological samples [51–53,53,54].

2.4. Surgical approach

The indication for surgical treatment followed a multidisciplinary assessment protocol, with a diagnosis of refractory epilepsy and a decision based on the findings of magnetic resonance imaging, videoelectroencephalography, and neuropsychological assessment. Surgical strategies are divided into four types of approach: standard ATL, selective amygdalohippocampectomy (SAH), lesionectomy, and extended lesionectomy. The ATL is a procedure introduced by Falconer and Taylor in 1968 [55] and consists in a remotion of 4–5 cm of the anterior temporal lobe, including the amygdala and hippocampus. It is also known as nonselective amydalohippocampectomy. The SAH performed in our service was developed by Niemeyer in 1958 [56], using a transventricular approach of the mesial temporal region by the middle temporal gyrus (T2). Lesionectomy is defined as the surgical removing of a lesion that causes focal seizures. In cases in which epileptiform activity in the cortex around the lesion was diagnosed, either by VEEG or intraoperative electrocorticography, an extended lesionectomy was performed.

2.5. Statistical analyses

The Statistical Package for Social Sciences 19.0 (SPSS) for Windows (IBM, NY) was used to conduct descriptive statistical analyses. Frequency analyses were performed to determine the occurrence of episodic memory dysfunction and to characterize patient self-awareness. Dysfunction on RAVLT [46,47] and/or RUCHE-M [48,50] was defined as delayed retrieval recall at or below the 25th (A7). Memory profiles were classified as follows: normal (no episodic memory dysfunction despite the presence of a temporal lesion); typical (episodic memory dysfunction compatible with the side of the temporal lesion); atypical (episodic memory dysfunction contralateral to the side of the temporal lesion, such as visual memory dysfunction for left TLE); or dual modality (verbal and visual episodic memory dysfunction in patients with right or left TLE). Each patient received a performance rating using the PCRS-R-BR discrepancy scores percentiles (Zimmermann, Castro-Pontes, Kochhann, Prigatano, & Fonseca, submitted). The underestimation of cognitive abilities (UCA) was defined as a score at or below the 25th percentile. Impaired self-awareness was defined as a score at or above the 75th percentile. Normal awareness was defined as a score equivalent to the 50th percentile. The cutoff points used to characterize groups have been described in the literature as “low average” [57–60] or “suggestive of mild impairment” [61,62] in different domains.

An independent-samples Mann–Whitney test was used to compare patients with right vs. left TLE in terms of PCRS-R-BR scores. Spearman correlations (two-tailed) were used to examine correlations between PCRS-R-BR Patient, Relative, and Discrepancy scores, on one hand, and variables such as age, education, time elapsed since the epilepsy diagnosis, months after surgical treatment, delayed memory scores, anxiety and depression scores, and IQ, with a significance level of 0.05.

To explore the role of clinical variables in self-awareness and self-report, the following variables were considered as predictors according to correlation results: WASI total score, frequency of seizures before surgery, time elapsed since the epilepsy diagnosis, and depression. For the PCRS-R-BR Patient and Relative scores, we used a backward regression method to avoid inflation of type II error and exclusion of variables involved in suppressor effects. In backward regression, all predictors variables are included; however, after each iteration, one variable is excluded for not contributing to the model. For the PCRS-R-BR Discrepancy score, a simple linear regression was used since they correlated only with the frequency of seizure before surgical procedure.

3. Results

Frequency analyses for the entire sample indicated impaired verbal and/or visual memory performance appearing as ISA in 39.13% of patients (n = 9) and as UCA in 69.56% of patients (n = 16). The results of additional analyses performed to evaluate the memory and awareness profiles of this patient population showed that 30.4% of patients (n = 7) had UCA and episodic memory dysfunction; 21.73% of patients (n = 5) had ISA with episodic memory dysfunction; 21.7% of patients (n = 5) had normal awareness and episodic memory dysfunction; 17.39% of patients (n = 4) had ISA and normal episodic memory performance; 8.7% of patients (n = 2) had UCA and normal episodic memory; one patient (4.3%) had normal awareness and normal

Table 1
Case by case analyses of patients with temporal lobe epilepsy (n = 23).

	Age	Years of education	Gender	Handedness	HADS Anxiety	HADS Depression	WASI IQ	Time after epilepsy diagnosis (years)	Months after surgical procedure	Frequency of seizures before surgery by months	VEEG laterality	MRI laterality	Lesion site	Histopathology	Surgical approach
Patient 1	44	12	Male	Right	3	0	87	42	7.7	3	Bilateral	Left	Hippocampus	Hippocampal sclerosis	ATL
Patient 2	39	18	Female	Right	3	3	99	11	18.0	2	Left	Left	Mesial temporal lobe	Disembrioplasic Neuroepithelial Tumor	Extended lesionectomy
Patient 3	28	12	Male	Right	4	1	95	25	19.8	3	Right	Right	Hippocampus	Hippocampal sclerosis	ATL
Patient 4	31	12	Male	Right	4	5	75	26	12.2	1	Right	Right	Hippocampus	Hippocampal sclerosis	ATL
Patient 5	54	16	Female	Right	3	9	98	51	41.8	5	Right	Right	Mesial temporal lobe	Hippocampal sclerosis	SAH
Patient 6	50	10	Female	Right	4	1	89	46	47.4	1	Left	Left	Hippocampus	Hippocampal sclerosis	ATL
Patient 7	42	19	Male	Left	4	1	105	22	45.8	1	Left	Left	Hippocampus	Hippocampal sclerosis	SAH
Patient 8	58	12	Female	Right	18	4	100	30	45.7	mv	Right	Right	Hippocampus	Hippocampal sclerosis	SAH
Patient 9	18	11	Male	Right	2	1	83	5	37.7	2	Bilateral	Left	Anterior temporal lobe	Anaplasic ganglioglioma	Extended lesionectomy
Patient 10	31	8	Male	Right	12	14	80	10	24.2	1	Bilateral	Right	Temporal inferior	Disembrioplasic Neuroepithelial Tumor	Lesionectomy
Patient 11	48	17	Male	Right	6	3	101	41	41.5	1	Bilateral	Left	Temporal anterior	Nodular neuronal heterotopia	ATL
Patient 12	52	16	Female	Right	1	1	90	27	15.0	1	Left	Left	Hippocampus	Hippocampal sclerosis	SAH
Patient 13	20	14	Female	Right	20	16	85	13	3.3	mv	Left	Left	Mesial temporal lobe	Hippocampal sclerosis	ATL
Patient 14	46	8	Male	Right	8	6	76	36	4.9	1	Bilateral	Left	Mesial temporal lobe	Hippocampal sclerosis	ATL
Patient 15	25	12	Male	Right	4	1	81	25	25.5	1	Left	Right	Hippcampus and parahippocampal gyrus	Ganglioglioma	Extended lesionectomy
Patient 16	37	13	Female	Right	0	1	92	31	11.8	2	Right	Right	Mesial temporal lobe	Hippocampal sclerosis	ATL
Patient 17	31	15	Male	Right	4	5	107	16	28.2	3	Bilateral	Left	Mesial temporal lobe	Hippocampal sclerosis	SAH
Patient 18	36	15	Female	Right	2	2	97	36	32.5	2	Right	Right	Mesial temporal lobe	Hippocampal sclerosis	ATL
Patient 19	33	13	Male	Right	2	3	84	33	30.5	6	Right	Right	Hippocampus	Hippocampal sclerosis	SAH
Patient 20	52	11	Female	Right	2	2	88	17	46.0	4	Left	Left	Mesial temporal lobe	Hippocampal sclerosis	ATL
Patient 21	30	12	Male	Left	9	4	91	30	36.0	2	Right	Right	Hippocampus	Hippocampal sclerosis	SAH
Patient 22	34	17	Male	Right	4	5	93	30	24.1	3	Left	Left	Hippocampus	Hippocampal sclerosis	SAH
Patient 23	38	12	Male	Right	5	2	87	37	28.0	2	Left	Right	Mesial and anterior temporal lobes	Ganglioglioma	Lesionectomy
Percentage			60.9% male/39.1% female	91.3% right/8.7% left								52.2% left/47.8% right			
Mean	38.1	13.3			5.4	3.9	90.6	27.8	27.3	2.2					
Std. Deviation	11.0	3.0			5.1	4.1	8.8	12.0	14.0	1.4					
Minimum	18	8			0	0	75	5	3.3	1					
Maximum	58	19			20	16	107	51	47.4	6					

Note. ATL = anterior temporal lobectomy; SAH = selective amygdalohippocampectomy; mv = missing value.

episodic memory. Table 2 presents these findings related to episodic memory and self-awareness in the study population.

The overestimation of memory performance was observed in individuals with ISA, alone or in combination with memory dysfunction. The frequency of memory performance overestimation was similar to that of other cognitive dysfunction evaluated by the PCRS-R-BR. Individuals with ISA and normal memory were most likely to overestimate their capacity to ask for help and to recognize when someone was upset. Patients with UCA and memory dysfunction tended to have high rates of underestimation (across the 17 items evaluated). Table 3 presents detailed clinical information for the study population.

Patients with UCA without memory dysfunction (n = 2) had the highest levels of anxiety and depression, were among the oldest patients included in the study, and had the longest duration since epilepsy diagnosis. Notably, both of these patients had right TLE (Table 3). Patients with UCA with memory dysfunction (n = 7) were the youngest among the study population, were mostly patients with left TLE, and had shorter duration since the epilepsy diagnosis. Patients with normal awareness and ISA did not show clinical symptoms of depression or anxiety. Patients with normal awareness and ISA were not more likely to have right or left lesion lateralization.

Overall, memory performance (presence or absence of dysfunction) and memory profiles (typical, atypical, normal, or dual modality) do not seem to be related to a specific self-awareness profile. The Mann–Whitney test was used to compare PCRS-R-BR scores between patients with left vs. right TLE. The results did not show predisposition toward right vs. left TLE among patients with impairment as detected with PCRS-R-BR patient reports ($p = 0.525$), PCRS-R-BR relative reports ($p = 0.608$), PCRS-R-BR Discrepancy scores ($p = 0.449$), or among patients with impairment as determined by scores on memory items 6 ($p = 0.525$), 7 ($p = 0.374$), and/or 8 ($p = 0.880$). Table 4 presents the results of correlational analyses for PCRS-R-BR scores and clinical or demographic characteristics.

The PCRS-R-BR relative report scores presented moderate positive correlations with the frequency of seizures in the month before surgery, indicating that the accuracy of relatives' reports on the patient's cognitive skills were associated with an increased number of seizures in the month leading up to surgical treatment. No correlation was found between the number of seizures before surgery and PCRS-R-BR Patient score; however, PCRS-R-BR Discrepancy score showed a moderate negative correlation with the frequency of seizures before surgical treatment. The HADS Depression score showed a moderate negative correlations with PCRS-R-BR Patient report score, indicating that the fewer depressive symptoms patients reported, the better they rated themselves on the PCRS-R-BR. Intelligence, as assessed by the WASI IQ, showed a moderate positive correlation with PCRS-R-BR Relative report scores, indicating that higher patient IQ was associated with better estimations of patient cognitive abilities in the relative reports. Finally, a moderate positive correlation was found between the time since diagnosis and PCRS-R-BR Patient score, indicating that the more time had elapsed since a patient's diagnosis with epilepsy, the better they rated themselves in terms of cognitive ability. Regression analyses indicated PCRS-R-BR scores were not significantly predicted by any of these variables, as can be seen in Table 5.

4. Discussion

The present study aimed to characterize self-awareness and episodic memory in patients with TLE who had undergone surgical treatment. Another aim was to investigate whether self-awareness was correlated with clinical and demographical variables such as lesion laterality, depression, anxiety, age, and time elapsed since surgical treatment. Frequency analyses of PCRS-R-BR score percentiles indicated that 39.13% of patients presented ISA (n = 9), 39.13% of patients presented UCA (n = 9), and 69.51% (n = 16) of patients presented impaired verbal or visual episodic memory. In summary, 73.93% of patients with TLE present some type of disturbance in terms of self-awareness. Analysis of this study population revealed six patient profiles: 30.4% of patients showed UCA and episodic memory dysfunction; 21.73% of patients showed ISA with episodic memory dysfunction; 21.7% of patients showed normal awareness and episodic memory dysfunction; 17.39% of patients showed ISA and normal episodic memory; 8.7% of patients showed UCA and normal episodic memory; one patient (4.3%) showed normal awareness and normal episodic memory. These findings show that most patients had self-awareness disturbances associated with episodic memory dysfunction. The frequency of seizures before surgical treatment showed a moderate positive correlation with PCRS-R-BR Relative score and a moderate negative correlation with PCRS-R-BR Discrepancy score. Depressive symptoms showed a moderate negative correlation with PCRS-R-BR Patient score. The time that had elapsed since the epilepsy diagnosis showed a moderate positive correlation with PCRS-R-BR Patient score. Regression models did not show significant correlations to confirm the predictability of these variables. Our findings indicate such variables are related to general cognition self-report and self-awareness. However, self-report and self-awareness of cognitive functioning are not significantly predicted by depression, intelligence score, time of epilepsy diagnosis, or number of seizures before surgical procedure. Some previous research that found these variables are predictors of perceived cognitive function are specifically related to memory, and not general cognition, in samples with patients that did not undergo epilepsy surgery [32,63]. Other studies also with nonsurgical patients found mood as a predictor of perceived cognitive function using other tools, as the Quality of Life in Epilepsy Inventory (QOLIE-89) [29] and the Aldenkamp–Baker Neuropsychological Assessment Schedule [35]. Therefore, it seems these variables predict self-report in nonsurgical samples, but the same does not apply to patients who undergo surgical procedure. These results are discussed further below.

Few studies published to date have investigated the incidence of ISA in patients with epilepsy. The presence of ISA or the underestimation of cognitive ability was higher in our study (n = 23; 78.26%) than in a previous study on patients with epilepsy with diverse foci and disease etiology. That study used The Multiple Ability Self-Report Questionnaire to detect cognitive dysfunction in patients (n = 85; 61%) [19]. In that study, the overestimation of cognitive ability (here described as ISA) was found in 28.42% of the sample, and the underestimation of cognitive ability (here described as the underestimation of cognitive ability) was detected in 32.63% of the sample population [19], as compared with 39.13% and 39.13%, respectively, in our study. Another study of patients with epilepsy with multiple foci (48.4% had TLE) found ISA in 29% of patients [18]. The findings of the present study suggest a higher occurrence of ISA and UCA in patients with TLE who have undergone surgical treatment than in patients with multiple foci epilepsy who did not undergo surgical treatment. Additional studies are required to test this hypothesis.

Notably, these previous studies relied on different methods to classify awareness function. For example, in evaluating the agreement between cognitive function and self-reported or cognitive performance indexes scores [19], positive discrepancy (patient minus relative) scores were classified as “aware”, while negative discrepancy scores were classified as “unaware” [18]. This high degree of variability in methods of assessment is common in the literature on self-awareness [64]. Therefore, the different methods used across studies to classify self-awareness should be considered when interpreting results.

Because informant relatives are typically close family members, relative reports are considered informative and reliable. At the same time, bias in these reports remains a concern. Potential sources of bias in relative reports include stress, anxiety, the recent nature of the patient's brain injury, and denial [64]. The moderate positive correlation observed between seizure frequency in the month before surgical treatment and PCRS-R-BR Relative scores, in combination with the lack of correlation with Patient score, suggest that the incidence of

Table 2
Patients' memory and awareness characterization.

Memory and anosognosia profiles		PCRS-R-BR Discrepancy Items										
	Patient identification and percentage of scores suggestive of ISA or UCA by PCRS-R-BR Discrepancy items	1 - Preparing ownmeals	2 - Taking care of finances	3 - Keeping appointments	4 - Starting conversation in a group	5 - Staying involved in work when tired	6 - Remembering last night's dinner	7 - Remembering names of people	8 - Remembering daily schedule	9 - Asking for help	10 - Adjusting to unexpected changes	11 - Handling arguments
ISA and memory dysfunction (n = 5)	1	0	1	0	0	0	1	-1	1	1	0	1
	6	0	0	0	0	0	0	0	0	0	1	0
	10	3	1	1	1	0	4	2	1	0	0	0
	12	0	1	0	2	1	0	0	0	0	0	4
	18	-1	0	0	0	2	0	0	1	2	3	2
		40%	60%	20%	40%	40%	40%	20%	60%	40%	40%	60%
ISA and normal memory (n = 4)	9	1	-1	0	0	1	2	0	0	2	0	0
	11	0	0	0	1	0	1	0	0	1	1	0
	15	0	-1	1	-2	2	0	0	0	2	2	2
	21	1	1	-1	0	0	0	0	0	0	0	1
		50%	25%	25%	25%	50%	50%	0%	0%	75%	50%	50%
UCA and normal memory (n = 2)	5	0	0	0	-1	-1	-2	0	-1	0	0	0
	8	0	-2	-2	0	-2	0	0	1	0	0	0
		0%	50%	50%	50%	100%	50%	0%	50%	0%	0%	0%
UCA and memory dysfunction (n = 7)	2	-1	-1	1	0	-2	-2	-1	-1	-2	-1	0
	3	0	0	0	-1	-1	-1	-1	-1	0	1	0
	13	1	-2	0	-1	-3	0	-3	-3	-3	-1	-2
	14	0	0	-2	-2	-2	0	0	0	-1	0	-1
	17	-1	-1	-2	1	0	-2	0	1	0	-1	0
	19	0	0	-1	0	-2	-1	0	-1	-2	-2	-1
	20	0	1	0	0	0	-1	0	1	0	0	0
		29%	43%	43%	43%	71%	71%	43%	57%	57%	57%	43%
Normal awareness and normal memory performance (n = 1)	7	0	0	0	0	0	0	0	0	0	0	0
Normal awareness and memory dysfunction (n = 4)	4	1	1	-1	-1	0	-2	0	0	1	0	0
	16	0	0	-1	0	1	0	0	1	1	0	-1
	22	0	0	0	0	0	0	0	0	0	0	0
	23	0	0	0	0	0	0	0	0	0	0	0

UCA in our sample (39.13%) may have been influenced by bias in relative reports. Relatives may have overestimated cognitive abilities of patients with TLE after surgical treatment due to their own improved satisfaction and quality of life as caregivers, resulting from the decreased frequency of seizures [65]. A similar phenomenon has been reported in children with cancer [66] and patients affected by perinatal arterial ischemic stroke [67]. Relative reports may thus be influenced by social desirability and/or expectation levels. Furthermore, UCA patients are likely to be more depressed than other patients with TLE and may therefore underestimate cognitive function, as reported in other studies of patients with neurologic disease [68,69].

We found a moderate negative correlation between depression and PCRS-R-BR Patient scores, suggesting that higher levels of depression were associated with underestimated cognitive function in self-reports from patients with TLE. This finding is corroborated by several studies reported in the literature. A study that found that patients with presurgical TLE that were depressed reported more memory deficits in spite of not differing from other patients with TLE without depression [70]. Another study of patients with focal epilepsy (54.5% TLE) found that psychological stress seems to explain a large portion of subjective memory complaints. Sawrie et al. [39] found that memory complaints of 65 patients who underwent ATL were predicted by mood and were not associated with objective memory performance. Similar findings have been reported in large and diverse samples with epilepsy [29,32,35]. In a study with first-seizure patients, cognitive complaints were strongly correlated to mood, but not to attentional functioning. In addition, authors suggested prior psychiatric vulnerability or condition predisposes patients to present more cognitive complaints [71]. Therefore, together, these findings suggest memory and general cognitive complaints of patients with epilepsy seem to be related to mood disorders in epilepsy in presurgical, postsurgical, and initial evaluation. Factors involved in the relationship between mood and cognitive complaints might involve cognitive distortions about self, others, and the future [72], how patients interpret the diagnosis of epilepsy [34], and situational distress due to a medical condition [71].

Moreover, other cognitive functions, such as attention, also influenced the self-perception of memory performance [63]. However, it is important to note that PCRS-R-BR Discrepancy score did not correlate with depression, suggesting that a patient's self-perception, but not self-awareness, of cognitive function was influenced by depressive symptoms. Giovagnoli [19] found no differences in depression or anxiety ratings between groups of patients with epilepsy who overestimated vs. underestimated performance. In our sample, we found a tendency of patients with UCA to report more depression when compared with patients with ISA; however, this trend was not significant.

Lesion laterality is a common topic of interest in the field of the neuropsychology of epilepsy [73–75] and in the field of self-awareness

Table 2 (*continued*)

PCRS-R-BR Discrepancy Items						PCRS-R-BR Patient	PCRS-R-BR Relative	PCRS-R-BR Discrepancy		RAVLT A7		RUCHE-M A7	
12 - Behaving properly around people	13 - Recognizing when someone is upset	14 - Scheduling daily activities	15 - Understanding new instructions	16 - Meeting daily responsabilities	17 - Keeping focused on tasks	Total Score	Total Score	Total Score	Percentile	Total Score	Percentile	Total Score	Percentile
1	0	0	1	0	1	72	65	7	75	3	<5	6	50-75
1	1	0	1	0	0	68	64	4	75	6	5-25	9	>75
0	-1	0	0	-1	0	44	33	11	75	4	<5	7	50
0	0	0	0	0	0	68	60	8	75	9	25-50	3	10-15
1	0	2	3	1	2	56	38	18	100	9	25	4	15-20
60%	20%	20%	60%	20%	40%								
0	-1	1	-1	1	-1	61	57	4	75	13	75	10	>75
0	2	0	1	0	0	68	61	7	75	11	75	5	25-50
3	2	0	0	2	0	59	46	13	100	15	95	9	50-75
2	1	0	0	0	0	69	64	5	75	10	25-50	7	50
50%	75%	25%	25%	50%	0%								
0	0	0	1	0	0	60	64	-4	25	12	75	6	25-50
0	0	0	0	0	0	53	58	-5	25	9	25-50	5	50-75
0%	0%	0%	50%	0%	0%								
1	1	-1	-1	-1	-1	49	61	-12	5	3	<5	1	<1
0	-1	0	0	-1	-1	61	68	-7	10	11	50	3	<1
0	1	-1	-2	-3	-2	37	61	-24	5	3	<5	9	50-75
-4	3	-1	0	2	-1	46	55	-9	10	13	75-95	3	20-25
1	1	-2	0	0	0	65	70	-5	25	11	50	4	15-20
-2	1	0	-2	0	0	53	66	-13	5	6	5	3	20-25
-2	0	-2	0	-2	-1	55	61	-6	10	3	<5	5	25-50
43%	14%	71%	43%	57%	71%								
0	0	0	0	0	0	68	68	0	50	13	75-95	6	25-50
1	1	0	0	0	0	59	58	1	50	6	5	4	1-20
0	0	0	0	0	0	66	65	1	50	13	75-95	1	<1
0	0	0	0	0	0	68	68	0	50	6	5	5	25
0	0	0	0	0	0	69	69	0	50	9	25	7	50

[38,70,76]. In this context, our results showed no differences between patients with right vs. left TLE patients in terms of self-awareness, self-reports, or PCRS-R-BR Patient, Relative, or Discrepancy memory items. A previous study suggested that right hemisphere but not left hemisphere epilepsy may be related to the overestimation of memory performance [38]. Notably, that study population included patients with subcortical and/or neocortical lesions in either the temporal or the frontal lobe, which limits comparison with our findings.

Research on the neuroanatomical basis of awareness has yielded conflicting results. However, there is substantial evidence demonstrating that bilateral cerebral dysfunction in various parts of the brain is associated with ISA (for a review, see [15]). Impaired self-awareness has been associated with various brain regions, including the ventral medial prefrontal cortex [77,78], anterior temporal lobe [78], and right parietal cortex [11]. The results of a study of patients with Alzheimer's disease indicated that anosognosia is related to a disconnection between the medial temporal lobe and the default mode network [79]. The present results support the view that temporal lobe lesions can impair self-awareness of cognitive function in approximately 40% of patients with TLE. Some studies have described a role for the temporal lobe in the phenomenological experience of self-awareness. The relevant studies published to date tended to include patients with neurodegenerative disease affecting brain networks that participate in the experience of awareness. These brain networks are connected to the temporal lobe through projections from the entorhinal cortex. Moreover, studies on cognitive self-awareness and neurodegenerative disease affecting the temporal lobe have reported a tendency toward the engagement of bilateral hippocampus and parahippocampal cortices [80].

Our findings indicate that episodic memory performance is not correlated with self-awareness or self-reports of cognitive function in patients with TLE. This finding is corroborated by two previous studies of patients with epilepsy. The first study, which included 99 patients with TLE (54%; frontal, 15.2%; occipital, 7.1%; multilobar, 13.1%; nonspecified location, 10.1%) reported a weak correlation between the self-perception of memory function and test performance [63]. The second study, which included patients with epilepsy with different lesion sites (48.4% of patients had TLE), reported no correlation between patient-informant discrepancy score and cognitive performance [18]. Taken together, these findings indicate that memory function does not seem to be a strong predictor of self-awareness of cognitive function in patients with epilepsy.

In this scenario, it is important to note that the PCRS-R-BR may be used to investigate a wide range of abilities—not only those processed by temporal lobe structures. Because impairments of self-awareness may be modality specific, our findings represent a more general cognitive perspective on self-awareness in patients with TLE, rather than a specific perspective on cognitive functions affected by the

Table 3
Clinical and demographical characterization of self-awareness and memory profiles.

	ISA and memory dysfunction	ISA and normal memory	UCA and normal memory	UCA and memory dysfunction	Normal awareness and normal memory performance	Normal awareness and memory dysfunction
	n = 5	n = 4	n = 2	n = 7	n = 1	n = 4
	Median/frequency/percentage					
Age (years)	44	28	56	33	42	36
Education (years)	12	12	14	13	19	13
Gender	2 M/3 F	4 M/0 F	0 M/2 F	4 M/3 F	1 M	3 M/1 F
HADS Anxiety	3	5	11	4	4	4
HADS Depression	1	2	7	3	1	4
Years since diagnosis	36	28	41	17	22	31
Frequency of seizures before surgery	1	2	5	3	1	2
Months after surgical treatment	24	37	44	20	46	18
Lesion laterality	60% left/40% right	50% left/50% right	0% left/100% right	71.4% left/28.6% right	100% left	25% left/75% right
Memory profiles						
Typical	40%	0%	0%	43%	0%	25%
Atypical	40%	0%	0%	29%	0%	25%
Dual	20%	0%	0%	29%	0%	50%
Normal	0%	100%	100%	0%	100%	0%

Table 4
Correlation analyses between PCRS-R-BR scores, clinical and demographical variables, and memory performance.

		PCRS-R-BR Relative	PCRS-R-BR Discrepancy	Age (years)	Education (years)	Time since diagnosis	Months after surgical treatment	Frequency of seizures before surgery (months)	HADS Depression	HADS Anxiety	WASI IQ	RUCHE-M A7 Total	RAVLT A7 Total
PCRS-R-BR Patient	rho	**,563****	**,427***	.135	.197	**,428***	.175	−.012	**−,532****	−.154	.286	.178	.202
	p	**.005**	**.042**	.538	.367	**.042**	.423	.958	**.009**	.482	.186	.416	.355
	n=	**23**	**23**	23	23	**23**	23	21	**23**	23	23	23	23
PCRS-R-BR Relative	rho		−.388	.025	.366	.205	.071	**,510***	−.166	−.084	**,441***	−.133	.000
	p		.067	.909	.086	.347	.749	**.018**	.448	.704	**.035**	.547	.999
	n=		23	23	23	23	23	**21**	23	23	**23**	23	23
PCRS-R-BR Discrepancy	rho			−.041	−.094	.176	.116	**−,509***	−.368	−.130	−.103	.323	.191
	p			.852	.671	.422	.597	**.019**	.084	.555	.641	.133	.383
	n=			23	23	23	23	**21**	23	23	23	23	23

* p minor or equal to 0.05.
** p minor or equal to 0.01.

temporal lobe. Another limitation of this study was the small sample size, the heterogeneity of lesion location, lack of information about antiepileptic drugs, and the heterogeneity surgical approach among patients with TLE. These factors may have impacted results. Future research on this topic should investigate specific characteristics of the relatives of patients with TLE after temporal lobectomy, such as coping mechanisms, social desirability in reporting patient outcomes, and emotional state.

Table 5
Multiple and simple linear regression analyses of performance in PCRS-R-BR scores.

	Variables				Model		
	B	SE (B)	Β	p value	Adjusted R2	p value	95% Confidence Interval
PCRS-R-BR Patient							
Model 1					−0.083	0.858	
Time after epilepsy diagnosis (years)	−0.106	0.249	−0.097	0.676			−0,625–0,413
HADS Depression	0.177	0.728	0.056	0.810			−1341–1695
Model 2							
Time after epilepsy diagnosis (years)	−0.12	0.236	−0.111	0.615	−0.035	0.615	−0,611–0,37
PCRS-R-BR Relative							
Model 1					−0.106	0.963	
WASI	0.034	0.294	0.027	0.91			−0,584–0,652
Frequency of seizures before surgery by months	0.418	1.83	0.054	0.822			−3427–4263
Model 2							
Frequency of seizures before surgery by months	0.451	1.76	0.059	0.801	−0.049	0.801	−3233–4135
PCRS-R-BR Discrepancy Items							
Number of seizures before surgery by months	−1.732	1.544	−0.249	0.276	0.013	0.276	−4963–1498

Declaration of competing interest

The authors declare no conflicts of interest.

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