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Test-specific differences in verbal memory assessments used prior to surgery in temporal lobe epilepsy

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ABSTRACT

Objective: To study the relationship between two commonly used verbal memory tests in presurgical evaluation for temporal lobe epilepsy (TLE) in Sweden, the Claeson–Dahl Test for verbal learning and retention (CDT) and the Swedish version of the Rey Auditory Verbal Learning Test (RAVLT).
Methods: Fifty-nine patients with TLE (male: 41%, mean: age 41.7 ± 12.3 years; epilepsy onset at mean age: 18.3 ± 13.1 years) previously tested with the CDT, the RAVLT, and three nonverbal memory tests on the same occasion were included. We performed (1) a principal component analysis (PCA) on test performances in the CDT and the RAVLT as well as in nonverbal memory tests; (2) a Pearson's correlation analysis for memory components, biological age, education, age at epilepsy onset, and self-rating scores for depression and anxiety; and (3) an estimation of clinically significant verbal memory impairment in patients with left TLE and left-sided hippocampal sclerosis.
Results: The PCAs showed coherence between the learning variables of the CDT and the RAVLT and divergence between the recall variables of the two tests. The RAVLT delayed recall variable was correlated to four out of five nonverbal memory measures. Both tests showed 70–80% clinically significant impairment of verbal memory in patients with left TLE, with or without hippocampal sclerosis, similar to other cohorts with resistant TLE.
Conclusions: The construct structure of the two verbal memory differs. It was shown that the RAVLT correlated with visuospatial memory, whereas the CDT did not. The study highlights that there are important nonoverlapping features regarding verbal recall of the two tests, indicating that these tests cannot fully replace one another.

1. Introduction

Temporal lobe epilepsy (TLE) is associated with memory impairment [1–3]. In addition, studies have shown aggravated verbal memory deterioration in up to 70% of patients after language-dominant temporal lobe resection (TLR) [4–7]. Yet, TLR is the most common procedure in adult epilepsy surgery with a 70% chance of seizure freedom [8]. Presurgical neuropsychological assessment aims to detect and quantify functional deficits in the seizure-generating temporal lobe and estimate the reserve capacity in the contralateral temporal lobe as well as the probability of a postsurgical memory deficit [9,10]. Intact verbal memory is often an indication for excluding patients from TLR in the language dominant hemisphere on the basis of a high risk of postsurgical verbal memory decline. The rationale is that episodic memory in the adult brain is material-specific, with verbal memory retention being mediated by the language-dominant temporal lobe, while visuospatial memory retention depends more heavily on the nonlanguage dominant temporal lobe [11,12]. This rationale has dominated the field of epilepsy surgery for decades, although recent research on cognitive effects of epilepsy surgery has come to question this dichotomy between verbal and visuospatial memory [13].

To correctly estimate pre- and postsurgical memory performance, it is crucial that the neuropsychological tests applied possess robust psychometric properties. Evidence shows that corresponding outcome measures from different verbal memory tests do not necessarily converge, suggesting that they assess slightly different aspects of memory [14,15]. This is presumably due to different test-specific building blocks activating different memory features in a test-unique manner. For example, different tests are made up of wordlists, sentences, or short stories. The material to be remembered can contain abstract or concrete verbal information, or a mixture of both. The possibility of random or

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logical combinations of this material cannot be excluded. Diverse test characteristics may entail different mnemonic strategies. The presentation schemes for test material vary across tests in terms of number of learning trials, time between learning and recall, and whether or not distraction material between presentation and recall is present. While some tests measure free recall, other tests measure cued recall. It is therefore likely that verbal memory tests have dissimilar demands on different aspects of memory, for example, verbal versus visuospatial memory.

A wide variety of verbal memory tests are used in the assessment of patients with epilepsy [16–18]. A recent report from E-PILEPSY (a European pilot network of reference centers in refractory epilepsy and epilepsy surgery) showed that the memory tests used for presurgical evaluation differ considerably between European centers, with the Rey Auditory Verbal Learning Test (RAVLT) most frequently used for verbal memory [19].

The fact that the different tests used for estimating the same function do not perhaps fulfill these criteria can be problematic both for clinical reasons and for research on the effects of TLR on memory. An overestimation of verbal memory performance during presurgical evaluation could falsely exclude patients that would have benefitted from TLR while an underestimation could result in approval of surgery despite high risk of postsurgical verbal memory decline. The question of whether different verbal memory tests, and measures within the tests, can be regarded as interchangeable is legitimate yet difficult to answer given the sparse empirical evidence regarding the construct structure and construct validity of common verbal memory tests used in patients with epilepsy.

In this study, we investigated the structural relations between the two most common tests used for presurgical work-up TLR in Sweden: the Swedish Claeson–Dahl Test (CDT) for verbal learning and retention [20] and the Swedish version of the RAVLT [21]. We examined the relations of constructs built from measures of these two tests combined with other neuropsychological and psychological measures, demographics, and epilepsy-related factors. Finally, to characterize our cohort, we defined the sensitivity of the CDT and the RAVLT in the assessment of clinically significant verbal memory impairment in patients with left TLE with or without mesial sclerosis.

Table 1
Sample characteristics.

	n
Sex	
Male	24 (41%)
Female	35 (59%)
Handedness	
Right	43 (73%)
Left	12 (20%)
Ambidextrous	4 (7%)
Language-dominance defined by	
fMRI	31 (53%)
Wada	2 (3%)
EHI[a]	57 (97%)
Temporal lobe epilepsy diagnosis	
Right	18 (31%)
Left	30 (51%)
Bilateral	9 (15%)
Unclear lateralization	2 (3%)
TLR prior to neuropsychological assessment	
No resection	45 (76%)
Right TLR	14 (24%)
MR pathology in patients with left TLE (n = 30)	
Left mesial sclerosis	10 (33%)
Left increased hippocampal signal or reduced volume	2 (7%)
Left extrahippocampal temporal lobe pathology	6[b] (20%)
Left extratemporal pathology	3[c] (10%)
Bilateral mesial sclerosis	2 (7%)
Seizure frequency	
Seizure-free	13 (22%)
>1 seizure/week	25 (42%)
>1 seizure/month	16 (27%)
>1 seizure/six months	5 (9%)
Antiepileptic drug treatment	
Off AEDs	5 (9%)
Monotherapy	14 (24%)
Polytherapy	40 (68%)

[a] EHI = Edinburgh Handedness Inventory.
[b] Frontotemporal heterotopia connected with hippocampal structures, anterior temporal cortical dysplasia, increased signal amygdala, enlarged amygdala bilaterally, posttraumatic parietotemporal lesion, or bilateral subependymal heterotopia.
[c] Polymicrogyria, hamartoma right hypothalamus, or posttraumatic parietooccipitotemporal lesion.

2. Methods

2.1. Patient selection and characteristics

Inclusion criteria were (a) a diagnosis of TLE and (b) availability of test results from both the CDT and RAVLT, in patients at the Department of Neurology and Rehabilitation Medicine at Skåne University Hospital in Lund, Sweden. Sixty-three patients initially fulfilled the inclusion criteria. Four patients were excluded because of an intelligence quotient (IQ) < 70 based on the Wechsler Adult Intelligence Scale or CDT/RAVLT testing through an interpreter (in the patient's native language). The remaining 59 patients had been evaluated either for TLR at our epilepsy surgical center between 2010 and 2017 (n = 57) or because of subjective memory deterioration (n = 2). Fourteen patients had received right TLR prior to the neuropsychological assessment.

Patients had a mean age of 41.7 years (standard deviation (SD): 12.3, range: 23–68), and the mean age at epilepsy onset was 18.3 years (SD: 13.1, range: 1–60). Patients had a mean education of 13.4 years (SD: 3.0, range: 9–20). Other demographic and epilepsy-related characteristics are presented in Table 1.

2.2. Neuropsychological assessment

Neuropsychological test data were extracted from the patients' medical records. All memory tests were administered in one session per patient. In all cases, the tests were presented in the same order, with no verbal or visuospatial memory tests overlapping during the assessment. Assessments were performed in an essentially uniform way with all patients tested with a minimum of two verbal memory tests, three visuospatial memory tests, and one verbal naming test as described below.

2.2.1. Verbal memory tests

The CDT comprises a 10-item wordlist that is to be repeated by the test person after a latency period of 15 s (from having heard the list read by the test administrator) over 10 trials or until it is correctly recalled twice and then again after 30 min [20]. The list of words contains eight abstract words (adjectives, verbs, pronouns, relative pronouns, conjunctions, and adverbs) and two concrete words (nouns). The total learning score of the CDT is made up of the number of *not* learned words in each of the ten learning trials multiplied by the number of the trial, meaning that for every trial, the performance is scored as worse for the words not remembered. The retention score of the CDT is built up from the percentage of the maximum words remembered (at any of the ten learning trials) during the learning trials compared to after 30 min.

The Swedish version of the RAVLT consists of a 15-item wordlist which the patient is asked to repeat five times and then recall immediately after each trial, then after a brief distraction by another wordlist, and again after 30 min [21]. The RAVLT wordlist contains 15 nouns. The total learning score of the RAVLT is the sum of words remembered over all five learning trials. The retention raw score is the number of words recalled after 30 min.