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Unique and shared validity of the ''Wechsler logical memory test'', the ''California verbal learning test'', and the ''verbal learning and memory test'' in patients with epilepsy

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Summary
Rationale: This study was set-up to evaluate the construct validity of three verbal memory tests in epilepsy patients.
Methods: Sixty-one consecutively evaluated patients with temporal lobe epilepsy (TLE) or extra-temporal epilepsy (E-TLE) underwent testing with the verbal learning and memory test (VLMT, the German equivalent of the Rey auditory verbal learning test, RAVLT); the California verbal learning test (CVLT); the logical memory and digit span subtests of the Wechsler memory scale, revised (WMS-R); and testing of intelligence, attention, speech and executive functions.
Results: Factor analysis of the memory tests resulted in test-specific rather than test over-spanning factors. Parameters of the CVLT and WMS-R, and to a much lesser degree of the VLMT, were highly correlated with attention, language function and vocabulary. Delayed recall measures of logical memory and the VLMT differentiated TLE from E-TLE. Learning and memory scores off all three tests differentiated mesial temporal sclerosis from other pathologies. A lateralization of the epilepsy was possible only for a subsample of 15 patients with mesial TLE.
Conclusion: Although the three tests provide overlapping indicators for a temporal lobe epilepsy or a mesial pathology, they can hardly be taken in exchange. The tests have different demands on semantic processing and memory organization, and they appear differentially sensitive to performance in non-memory domains. The tests capability to lateralize appears to be poor. The findings encourage the further discussion of the dependency of memory outcomes on test selection.

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Introduction

Memory impairment represents a major cognitive problem for epilepsy patients in general and for those with temporal lobe epilepsy (TLE) in particular. In patients with TLE there is an additional risk of memory impairment when surgery is performed to control pharmacoresistant seizures (Loring et al., 2008a). In this context, verbal memory plays an exceptional role since it becomes quite systematically involved when temporal lobe surgery is performed in the language dominant hemisphere (Lee et al., 2002). Accordingly, the pre- and post-operative assessment of memory became a standard for the quality and outcome control of TLE surgical treatment. The relevance of this quality management becomes particularly evident in recent discussions about the superiority of different surgical approaches in regard to cognitive outcome. While there is no evidence suggesting a different seizure outcome for different temporal lobe surgeries (Schramm, 2008), there is converging evidence showing that cognitive outcomes can be optimized with more selective and tailored resections (Clusmann et al., 2002; Helmstaedter et al., 1996, 2007; Hori et al., 2007; Jones-Gotman et al., 1997; Morino et al., 2006). The results, however, are not always consistent, and one may well discuss with these studies that different neuropsychological outcomes not only depend on patient characteristics or the surgical approach, but also on the dependent neuropsychological measures chosen for outcome control.

There are numerous ways of testing verbal memory in epilepsy patients. In a survey dating back to 1993, Marilyn Jones-Gotman and colleagues collected information from the test batteries used in 82 epilepsy centres performing epilepsy surgery (Jones-Gotman et al., 1993). At that time, the Wechsler memory scale (WMS) and its revised version (WMS-R) were used by the majority of the consulted centres for the assessment of verbal memory. The logical memory and the paired associate word learning task of the WMS were used by 82% and 64%, respectively; the Rey auditory verbal learning test (RAVLT) was used by 35%; and the California verbal learning tests (CVLT) was used by 15% of the centres. Although this survey may no longer reflect the present situation, it proves that epilepsy centres use to rely on different tests.

The available verbal memory tests differ with regard to quantity (number of items or chunks) and quality (unrelated, semantic relations, story) of the material to be learned. Most importantly, the tests follow different test protocols (i.e. repeated learning vs. one learning trial, distraction, cued recall, and recognition). The tests can thus be expected to differ with regard to their demand on different aspects of verbal learning and memory (e.g. short-term/long-term memory), and they may also have different demands on non-memory functions (e.g. intelligence, language, and attention). This raises the decisive question whether different measures of verbal learning and memory performance assess the same cognitive constructs and whether they have comparable clinical validity in regard to seizure characteristics including location (side, lobe) and pathology. The present study compared the construct validity and clinical validity of the verbal learning and memory test (Helmstaedter et al., 2001b) (VLMT, the German equivalent to the Rey auditory verbal learning test, RAVLT), the CVLT (Delis et al., 1987), and the logical memory from the WMS-R (Härting et al., 2000). In what follows the validity of these tests in regard to temporal lobe epilepsy will be reviewed.

The VLMT as a verbal list learning procedure is acknowledged as a valid measure of verbal episodic declarative memory, and it reliably reflects the different memory profiles of TLE with left mesial or lateral focus (Helmstaedter, 2005; Helmstaedter et al., 1997, 1999, 2008). The CVLT is also a list learning test but different from the VLMT its items are semantically related (shopping list with subcategories) rather than unrelated. This procedure allows testing of strategies and processes involved in learning and remembering verbal material. Hermann et al. (1992) reported that after left temporal resection, patients used significantly more serial clustering, whereas those patients who underwent right temporal resection showed significantly more semantic clustering, which is the more efficient strategy. Patients who underwent a left temporal resection showed increased forgetfulness after a short delay, but there were no differences in the absolute number of words learned in trials one to five (Hermann et al., 1992). Wyler and colleagues, in their randomized trial on the effects of different degrees of mesial sclerosis and mesial resections on memory outcome after surgery, showed that total learning, short delayed recall, and the learning slope of the CVLT were sensitive with regard to left sided surgery in the absence of hippocampal sclerosis only (Wyler et al., 1995), i.e. removal of a non-sclerotic but not of a sclerotic left hippocampus caused significant losses in the respective outcome parameters of the CVLT. Similarly left sided resections of non-sclerotic hippocampi caused greater losses in immediate and delayed recall performance in the logical memory subtest of the WMS. No effect of the extent of the resection on memory outcome was observed in this study.

In regard to the logical memory of the WMS-revised (WMS-R), some studies report that this subtest is sensitive towards left hemispheric impairment (Hendriks et al., 2004; Moore and Baker, 1996). Other evidence suggests that this test may provide false lateralizing information (Kneebone et al., 1997). Inconsistent lateralizing information resulting from logical memory testing is also reported for the WMS-III (Akanuma et al., 2003; Baker et al., 2003; Wilde et al., 2001). However, significant correlations between WMS-III logical memory and hippocampal volumes have been demonstrated (Griffith et al., 2004). In another study on memory outcome in relation to the extent of TLE surgery, Joo et al. (2005) found correlations of the extent of left temporal lobe surgery and performance in WMS-R logical memory (Joo et al., 2005).

A recent retrospective study compares the RAVLT with the CVLT using data from the *Bozeman Neuropsychological Epilepsy Database* (Loring et al., 2008b). The results indicated a better sensitivity of the RAVLT over the CVLT with regard to a left lateralization of TLE. However, the tests in this study were not applied to the same patients. The present study differed from Loring's in that it prospectively compared the tests among 61 consecutive patients with focal symptomatic or cryptogenic epilepsies. The major question of this study was whether three memory tests, which differ with regard to the materials and the test schedule, would share the same or different memory constructs