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Comparison between two scoring systems of the Rey–Osterrieth Complex Figure in left and right temporal lobe epileptic patients

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Abstract

The Rey–Osterrieth Complex Figure (ROCF) is probably one of the most popular measurement instruments of visuoconstructional abilities and nonverbal memory. It is frequently part of neuropsychological test protocols in epilepsy surgery centers. In this study we compared the traditional scoring system of the ROCF developed by Taylor (1998) with a qualitative system that assesses spatial-relational errors devised by Loring et al. [Loring, D. W., Lee, G. P., & Meador, K. J. (1988). Revising the Rey–Osterrieth: Rating right hemisphere recall. *Archives of Clinical Neuropsychology*, *3*, 239–247] in a sample of left and right temporal lobe epilepsy patients undergoing pre-surgical evaluation. We investigated whether the relational-spatial scoring system would be more sensitive to right-sided memory deficits than the traditional Taylor version. There was no difference in the copy phase of the ROCF between the clinical and control groups. There was a significant difference between the control and the clinical groups when the 30-min delayed recall drawings were scored with the Taylor system. However, this system failed to find differences between left and right temporal lobe epileptic patients. On the other hand, comparisons with the qualitative scoring criteria used by Loring et al. [Loring, D. W., Lee, G. P., & Meador, K. J. (1988). Revising the Rey–Osterrieth: Rating right hemisphere recall. *Archives of Clinical Neuropsychology*, *3*, 239–247] revealed that right temporal lobe patients made more spatial-relational errors than patients with left-sided foci. Frequency distribution of these scores for all the three groups and sensitivity and specificity to correctly classify right temporal lobe patients are presented. This investigation demonstrated that applying qualitative, material-specific scoring criteria improves temporal lobe epilepsy presurgical protocols.

Keywords: Temporal lobe epilepsy; Figural recall tests; Memory; Epilepsy surgery

1. Introduction

Most epilepsy neuropsychological protocols include measures of figural reproduction and recall in order to analyze differences in relation to lesion and seizure laterality (Jones-Gotman, Smith, & Zatorre, 1993; Mader, Damasceno, Frank, & Portuguez, 2001). While there is strong evidence of verbal memory losses associated with left seizure foci and left hippocampus sclerosis (Alessio et al., 2006; Kilpatrick et al., 1997; Mungas, Ehlers, Walton, & McCutchen, 1985; O'Brien, Bowden, Bardenhagen, & Cook, 2003), the association between right temporal seizure foci and delayed

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figural reproduction in presurgical samples has yielded rather inconsistent findings across epilepsy surgery centers (Barr et al., 1997; Helmstaedter, Pohl, and Elger (1995)).

From a measurement perspective, figural materials may not be reliable instruments of nonverbal memory to the extent that figurative stimuli can be verbalized and mediated by language-based operations. Helmstaedter, Pohl, and Elger (1995) compared left and right temporal epilepsy patients and controls on visual memory tests. They found that visual memory deficits in right temporal lobe patients became evident only when the verbal load of the figural material was beyond subjects' verbal learning capacity. From a more theoretical perspective, it has been argued that nonverbal measures have to be improved in order to address the particular processing quality of the dysfunctional area (Barr, 1997).

Among the nonverbal memory instruments, the Rey–Osterrieth Complex Figure (ROCF) stands out as one of the most widely used instruments in both clinical and experimental settings to evaluate visuoconstructional abilities and nonverbal memory (Spreen & Strauss, 1998). The importance of the ROCF is justified by its predominantly visual quality in relation to the other instruments.

Different scoring systems have been developed in order to evaluate the accuracy of the reproduction of the ROCF. Loring, Lee, and Meador (1988), searching to improve the sensitivity of the ROCF to right temporal lobe damage, devised a scoring system that targets qualitative spatial-relational type of errors. This system was initially administrated to a single group of epileptic patients and later cross-validated with another independent epilepsy sample. These authors found that their scoring system revealed more of the right hemisphere errors.

In the present study, we compared the traditional scoring system developed by Taylor (1998) and the qualitative scoring system of spatial-relational errors developed by Loring et al. (1988) in a sample of right and left temporal lobe epilepsy patients undergoing presurgical evaluation in a reference hospital.

2. Method

2.1. Subjects

The clinical group consisted of 78 subjects selected from a consecutive sample of right-handed patients undergoing comprehensive multidisciplinary evaluation as candidates for epilepsy surgery. All patients had a history of symptomatic intractable complex partial seizures of temporal lobe origin (LTE), according to the classification system of the International League Against Epilepsy (ILAE), and hippocampal sclerosis as visualized on brain magnetic resonance. All patients clinical neurological exams were considered normal and no other known condition relating to the seizure disorder was reported by the medical team. The majority of the patients referred to this particular epilepsy center come from rural regions with predominately elementary school education (see Table 2 for sample characteristics). Subjects in the control group gave their informed consent to participate in the research project. The participants in the control group were volunteers recruited at their work place. They performed technical, janitorial and domestic work in the university, homes, public sites and schools. A screening interview was conducted in order to exclude healthy participants who had a psychiatric or neurological disorder, sensorial or motor impairment, use of psychoactive drugs and/or alcohol, history of learning disability and non-corrected visual acuity difficulties.

Among the patients, 44 had right temporal lobe epilepsy foci (RTL) and 34 suffered from seizures originating from the left temporal lobe (LTL). The location of the seizure focus was determined from ictal and inter-ictal recordings from video-electroencephalographic monitoring with scalp electrodes and confirmed on magnetic resonance. The control group was composed of 34 subjects, matched according to gender, age and level of education to the epileptic patients.

2.2. Instrument and procedure

All subjects were evaluated by the same psychologist who is specialized in neuropsychological assessment with this client population. Patients were tested with a battery of intelligence, language, memory, visuoconstructional and attention tests. The battery followed test selection guidelines recommended by the Brazilian League Against Epilepsy (Mader et al., 2001). The figural memory test and scoring procedures employed in the study are described below.

Table 1
Scoring units developed by Loring et al. (1988).

Unit	Description
I	Diamond on stem (at the end of the main triangle)
II	Misplacement of the diamond
III	Rotation of the horizontal lines in upper left corner of rectangle
IV	Distortion of overall configuration
V	Inversion, misplacement, or distortion of upper right triangle
VI	Additional horizontal lines (six or more lines in upper left corner of rectangle)
VII	Additional parallel lines (repetition of horizontal lines in upper left corner of rectangle in other locations).
VIII	Misplacement of upper left cross outside of rectangle, or lower cross attached to vertical midline below rectangle
IX	Major misplacements
X	Additional lines: cross in upper left corner outside of rectangle and in cross attached to vertical midline below rectangle
XI	Incorporation of pieces into a larger element
XII	Partial (90°) or complete (180°) figure rotation

2.2.1. Rey–Osterrieth Complex Figure Test (Osterrieth, 1944)

This is a widely used figural copy and recall task of perceptual, planning and memory function. Subjects were provided with blank sheets of papers and were told to draw the complex figure as best as they could. There was no time limit set for the copy and recall. Initially, each subject was asked to copy the figure presented from a landscaped viewpoint and 30-min later, with no previous warning, each subject was given another blank sheet and asked to recall the design. During the 30-min interval the subjects were administered other tests. The ROCF was administered at the time of the full neuropsychological evaluation during inpatient admission for the pre-surgical investigation.

The drawings were scored according to the traditional guidelines developed by Taylor described in Spreen and Strauss (1998). This scoring system consisted of an assessment of 18 particular characteristics of the figure. Each of the 18 items was evaluated according to a two-point scale. Two points were given when the item was placed and reproduced correctly; 1 point when the item was reproduced incompletely placed incorrectly or presented some distortion; 0.5 point was attributed when the item was placed or reproduced poorly. A zero score was given when the item was absent or not recognized.

The delayed recall of the ROCF was scored according to the guidelines developed by Loring et al. (1988), presented in Table 1. This scoring system targets particular spatial-relational type of errors such as: rotation of segments (III, V); misplacement of details (VIII); major misallocation (II, IX); and distortions (IV, V, XI). According to this qualitative error guideline, patients received 1-point for the presence of one of the errors related to the units presented in Table 1. The final score represented the total number of qualitative errors made by the subject.

2.3. Data analysis

Results are presented as means and their respective standard error (±S.E.M.). A one-way analysis of variance (ANOVA) was employed to detect significant mean differences among right and left temporal lobe patients and healthy control subjects. Whenever the ANOVA was statistically significant, the Duncan post-hoc test was employed for pairwise comparisons. Once a significant difference between groups was detected, sensitivity and specificity analyses were performed to identify the power of this score to correctly classify the right temporal lobe patients. The chi-square test was used to disclose percentage differences among the three groups. Statistical significance level was set at $p < 0.05$.

3. Results

Table 2 presents the characteristics of our clinical (left and right temporal lobe epileptic patients) and control subject sample. There were no differences in gender distribution (χ^2 (2) = 0.9; $p > 0.9$), age ($F(2,111) = 0.4$; $p > 0.6$) and education level ($F(2,111) = 0.2$; $p > 0.8$) among the three groups.

The upper panel of Fig. 1 depicts the mean copy score of ROCF according to Taylor's guidelines (Spreen & Strauss, 1998). As can be observed in the Figure, right and left temporal lobe patients did not present any differences in comparison to control subjects. This impression was confirmed by a one-way ANOVA ($F(2,111) = 0.14$; $p > 0.8$). The

Table 2
Percentage and mean with the standard deviation in parenthesis of the demographic variables (sex, age and years of education) of right and left temporal lobe patients and healthy control subjects.

Group	Male	Female	Age	Education
Right	20	24	34.2 (8.3)	9.2 (3.6)
Left	16	18	35.2 (9.4)	8.7 (3.4)
Control	14	20	33.1 (11.5)	9.1 (4.1)

middle panel of Fig. 1 shows the mean of ROCF recall scores according to the traditional scoring system (Spreen & Strauss, 1998). A one-way ANOVA indicated statistical differences among the groups ($F(2,111) = 6.86$; $p < 0.01$). Post hoc analysis revealed that both left and right temporal lobe epileptic groups had lower scores as compared to the control group (all p's < 0.05). No differences between the two clinical groups were found ($p > 0.05$).

Finally, the lower portion of Fig. 1 presents the mean recall score of the ROCF spatial-relational type of errors developed by Loring et al. (1988) of the three groups. A one-way ANOVA indicated statistical differences among the

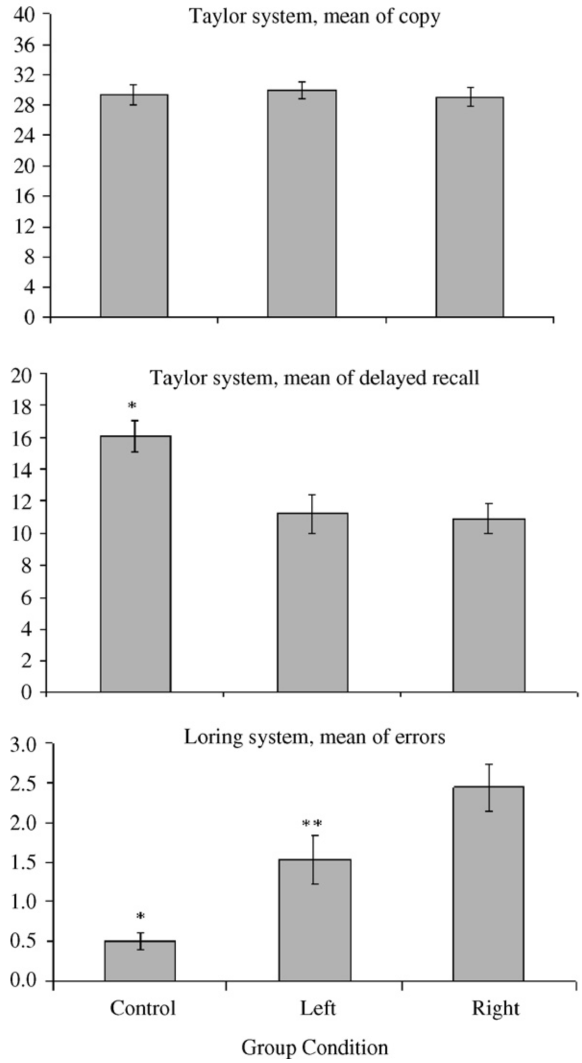

Fig. 1. Mean (±S.E.M.) mean of correct copy responses to ROCF (upper panel), recall (middle panel) and qualitative errors (lower panel) among control, right and left temporal lobe patients. See text for explanations.

Table 3
Sensitivity and specificity in predicting right temporal lobe epilepsy patients based on the Loring qualitative system.

Cutoff	Sensitivity (%)	Specificity (%)
1 or more errors	68.2	63.2
2 or more errors*	65.9	73.5
3 or more errors	45.5	83.8
4 or more errors	29.5	82.2

Asterisk indicates the best cutoff point.

Table 4
Frequency distribution of qualitative errors made by the control, right and left temporal lobe patients.

Number of errors	Group		
	Right (%)	Left (%)	Control (%)
0	31.8	50.0	76.5
1	2.3	11.8	8.8
2	20.5	11.8	8.8
3	15.9	5.9	2.9
4	9.1	8.8	2.9
5	11.4	5.9	0.0
6	9.1	5.9	0.0
Total	100	100	100

groups ($F(2,111) = 11.17$; $p < 0.01$). Post hoc analysis indicated left temporal lobe patients presented more errors when compared to the control group but fewer errors than right temporal lobe epileptic patients (all $p < 0.05$).

Table 3 presents the results of the sensitivity and specificity analysis. As it can be observed, sensitivity and specificity are inversely related, meaning that as the cutoff increases, sensitivity decreases and specificity increases. This analysis

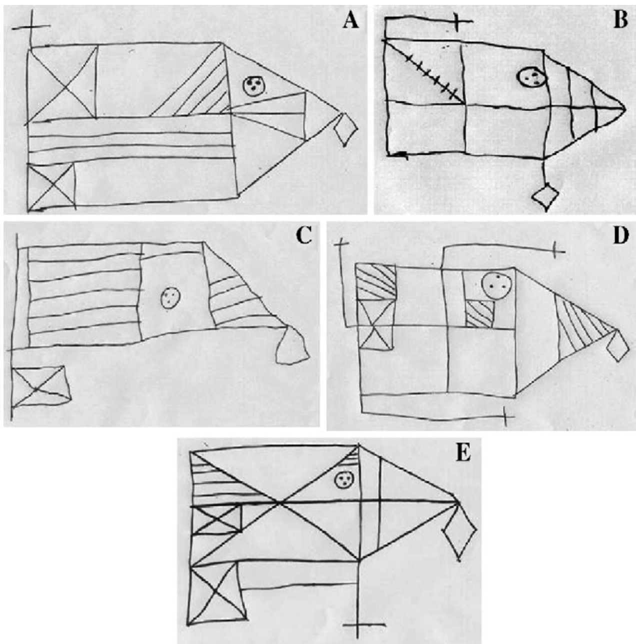

Fig. 2. Examples of qualitative errors made by right temporal patients. (A) III—Rotation of horizontal lines; IV—Distortion of overall configuration; V—Inversion, misplacement of upper right triangle; VIII—Misplacement of lower cross. (B) II—Misplacement of diamond. (C) II—Misplacement of diamond, III—Rotation of horizontal lines, IV—Distortion of overall configuration, VII—Additional parallel lines, IX—Major misallocation (rectangle placed outside of major rectangle). (D) VII—Additional parallel lines. (E) VIII—Misplacement of upper left cross.

identified two or more errors as the cutoff point that maximized sensitivity and specificity. Increasing the cutoff value did not considerably affect specificity but cause a drastic reduction in sensitivity. Frequency distribution of these scores for each group is presented in Table 4. This analysis indicated that 66% of the right temporal lobe patients presented two or more errors according to the spatial-relational system, whereas only 38% of the left temporal lobe patients and 15% of the control group reached the two or more error cutoff.

Fig. 2 presents illustrations of patients' delayed recall qualitative errors. Five examples of these qualitative errors made by right temporal lobe patients are depicted in this figure.

4. Discussion

The present work indicated that there is a trend for measurement improvement with the inclusion of specific guidelines when scoring the ROCF. Particularly, results supported the importance of the assessment of the spatial component of the patient's delayed recall beyond the verbal learning capacity of the subject (Breier et al., 1996; Helmstaedter et al., 1995; Loring et al., 1988).

Results confirmed that the Taylor scoring system of the ROCF is a useful assessment criterion of memory deficits in epileptic patients and that the application of more targeted scoring criteria improves this instrument. Applying the Taylor scoring system showed that the copy accuracy scores did not differ between the clinical and control groups, but the delayed recall scores were considerably lower in the temporal lobe groups in relation to controls (Fig. 1). However, this particular scoring system failed to disclose laterality differences between temporal lobe epilepsy groups. On the other hand, the use of a protocol that targets spatial-relational errors of the ROCF delayed recall improved this instrument's ability to reliable differentiate the performance between right and left temporal lobe groups.

Although the sensitivity and specificity of the spatial scoring system to right temporal lobe memory deficits were low (66% and 73% respectively), a closer inspection of the data reveals useful qualitative information. The incidence of spatial-relational errors among right temporal lobe patients was significantly higher when compared to left temporal lobe patients or healthy control subjects. Moreover, frequency distribution of these results indicates that the occurrence of more specific spatial-relational errors is unusual among healthy individuals. In this sample, 76% of the subjects did not present any errors in the free delayed recall of the complex figure when their reproductions were scored according to the Loring, Lee, and Meador (1988) criteria. Therefore, the incidence of spatial-relational errors in the ROCF cannot be employed as the only measure to detect the presence and/or absence of right temporal lobe epilepsy foci, though it might help to locate it when included as part of a neuropsychological evaluation battery.

The extent of the neuropsychological deficits varies within the same clinical groups due to disease-related factors. For instance, overtime patients suffering from refractory temporal lobe seizures tend to develop neuropsychological dysfunction beyond the temporal lobe (Aldenkamp & Bodde, 2005; Jokeit & Ebner, 1999). It is possible that low scores on visual spatial tests reflect confounding frontal lobe involvement because of the demand put on organizational ability in the copy and encoding of the complex figure. In this study, controls and clinical subjects did not differ in the accuracy score of the copy phase of the complex figure (upper panel of Fig. 1). The significant difference between the control and the clinical groups became apparent only when the memory component was scored (middle panel of Fig. 1). Therefore, the findings suggest that patients have satisfactory copy ability of complex figures when compared to healthy controls. It would be interesting in future studies to know more about the processing quality in the copy phase, particularly in terms of the sensitivity of the ROCF to frontal lobe, organizational dysfunction and the history of the disease. This would help to clarify the sensitivity of this test to disease-related factors and to understand its usefulness in the identification of deficit patterns in specific clinical groups.Although education is often viewed as being more influential in the performance of verbally mediated tasks than nonverbal tasks, Ardila, Rosselli, and Rosas (1989) and Berry, Allen, and Schmitt (1991) have found education to be an important factor in recall of the ROCF. Our patient group was notable in that this rural sample had a very low level of education. However, it is unlikely that education can account for the delayed recall deficit in our sample given that this deficit was apparent in comparison to a control group matched for education level.

This investigation, conducted in an epilepsy surgery center, supports the viewpoint that figural materials should be an important component of the neuropsychological battery even for the assessment of individuals who have more limited formal education. Overall findings confirmed that there is a need to develop new or modify existing nonverbal memory tests in order to better evaluate this function.

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References

Aldenkamp, A., & Bodde, N. (2005). Behaviour, cognition and epilepsy. *Acta Neurológica Scandinavica*, *112*(suppl. 182), 19–25.

Alessio, A., Bonilha, L., Rorden, C., Kobayashi, E., Min, L. L., Damasceno, B. P., et al. (2006). Memory and language impairments and their relationship to hippocampal and perirhinal cortex damage in patients with medial temporal lobe epilepsy. *Epilepsy and Behavior*, *8*, 593–600.

Ardila, A., Rosselli, M., & Rosas, P. (1989). Neuropsychological assessment in illiterates: Visuospatial and memory abilities. *Brain and Cognition*, *11*, 147–166.

Barr, W. B., Chelune, G. J., Herman, B. P., Loring, D. W., Perrine, K., Strauss, E., et al. (1997). The use of figural reproduction tests as measures of nonverbal memory in epilepsy surgery candidates. *Journal of the International Neuropsychological Society*, *3*, 435–443.

Barr, W. B. (1997). Examining the right temporal lobe's role in nonverbal memory. *Brain and Cognition*, *35*, 26–41.

Berry, D. T. R., Allen, R. S., & Schmitt, F. A. (1991). Rey–Osterrieth Complex Figure: Psychometric characteristics in a geriatric sample. *The Clinical Neuropsychologist*, *5*, 143–153.

Breier, J. I., Plenger, P. M., Castillo, R., Fuchs, K., Wheless, J. W., Thomas, A. B., et al. (1996). Effects of temporal lobe epilepsy on spatial and figural aspects of memory for a complex geometric figure. *Journal of the International Neuropsychological Society*, *2*, 535–540.

Helmstaedter, C., Pohl, C., & Elger, C. E. (1995). Relations between verbal and nonverbal memory performance: Evidence of confounding effects particularly in patients with right temporal lobe epilepsy. *Cortex*, *31*, 345–355.

Jokeit, H., & Ebner, A. (1999). Long term effects of refractory temporal lobe epilepsy on cognitive abilities: A cross sectional study. *Journal of Neurology, Neurosurgery and Psychiatry*, *67*, 44–50.

Jones-Gotman, M., Smith, M. L., & Zatorre, J. (1993). Neuropsychological testing for localizing and lateralizing the epileptogenic region. In J. Engel Jr. (Ed.), *Surgical treatment of the epilepsies* (pp. 245–262). New York: Raven Press.

Kilpatrick, C., Murnie, V., Cook, M., Andrewes, D., Desmond, P., & Hopper, J. (1997). Degree of left hippocampal atrophy correlates with severity of neuropsychological deficits. *Seizure*, *6*, 213–218.

Loring, D. W., Lee, G. P., & Meador, K. J. (1988). Revising the Rey–Osterrieth: Rating right hemisphere recall. *Archives of Clinical Neuropsychology*, *3*, 239–247.

Mader, M. J., Damasceno, B., Frank, J. E., & Portuguez, M. (2001). Critérios mínimos para procedimentos de avaliação neuropsicológica pré e pós-cirúrgica. *Journal of Epilepsy and Clinical Neurophysiology*, *7*, 104–105.

Mungas, D., Ehlers, C., Walton, N., & McCutchen, C. B. (1985). Verbal learning differences in epileptic patients with left and right temporal lobe foci. *Epilepsia*, *26*, 340–345.

O'Brien, C. E., Bowden, S. C., Bardenhagen, F. J., & Cook, M. J. (2003). Neuropsychological correlates of hippocampal and rhinal cortex volumes in patients with mesial temporal sclerosis. *Hippocampus*, *13*, 892–904.

Osterrieth, P. A. (1944). Le test de copie d'une figure complex: Contribution à l'étude de la perception et de la memoir. *Archives de Psychologie*, *30*, 286–356.

Spreen, O., & Strauss, E. A. (1998). *Compendium of neuropsychological tests. Administration, norms and commentary* (2nd ed.). New York: Oxford University Press.

Taylor, L. B. (1998). Scoring criteria for the Rey-Osterrieth Complex Figure Test. In O. Spreen & E. Strauss (Eds.), *A compendium of neuropsychological tests. Administration, norms, and commentary*. New York (NY): Oxford University Press, pp. 350–351.