RESEARCH PAPER

# REHACOM COGNITIVE REHABILITATION ON THE NEUROCOGNITIVE STATUS OF PATIENTS WITH TEMPORAL LOBE EPILEPSY AFTER ANTERIOR TEMPORAL LOBECTOMY

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## Abstract

*Objective*: This study aims to evaluate the effectiveness of RehaCom cognitive rehabilitation in improving neurocognitive functions in patients with temporal lobe epilepsy (TLE) following anterior temporal lobectomy (ATL), a common surgical intervention for medically refractory epilepsy.

*Method*: A total of 12 patients who had undergone ATL participated in a 10-session RehaCom rehabilitation program. Cognitive assessments were conducted pre- and post-intervention, measuring verbal memory, figural memory, attention, and executive function. Cognitive improvements were analyzed using repeated measures ANOVA and non-parametric tests to evaluate changes in performance and the effect of the surgery side on outcomes.

*Results*: Significant improvements were observed in verbal memory, working memory, and learning ability, especially in patients who underwent left anterior temporal lobectomy. Overall, cognitive improvements were evident across both groups, though specific patterns of recovery differed depending on the side of the surgery.

*Conclusions*: RehaCom cognitive rehabilitation significantly improves cognitive functions, particularly in memory, attention, and executive function, following ATL. The side of surgery plays a role in determining specific outcomes, with left ATL patients benefiting more in verbal memory. These findings support the use of RehaCom as a multi-domain, adaptive rehabilitation tool for enhancing cognitive recovery in TLE patients post-ATL.

**Key words**: epilepsy, temporal lobectomy, surgery, seizure, rehabilitation, RehaCom, neurocognitive function

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## Introduction

Epilepsy is a prevalent neurological disorder affecting approximately 50 million people worldwide, characterized by recurrent and unprovoked seizures (Sirven, 2015). Despite significant advancements in antiepileptic drug (AED) therapy, about 30% of epilepsy patients continue to experience seizures that are refractory to medical treatment. For these individuals, surgical interventions such as anterior temporal lobectomy (ATL) offer a viable alternative for achieving seizure control (Gompel et al., 2013). ATL, which involves the resection of the anterior portion of the temporal lobe, is particularly effective for patients with medical refractory temporal lobe epilepsy (TLE). However, while ATL can significantly reduce or eliminate seizures, it is associated with the risk of cognitive deficits, particularly in memory and executive functions, due to the removal of brain tissue critical for these cognitive processes (Wong et al., 2009).

The cognitive impairments observed post-ATL can severely impact the quality of life and daily functioning of patients(Krámská et al., 2022). Memory deficits are among the most frequently reported cognitive challenges following ATL(Surgery, 2020). Patients may experience difficulties with verbal memory, especially if the dominant (usually left) temporal lobe is resected, and non-verbal memory when the non-dominant (usually right) temporal lobe is affected. Additionally, attention and executive functions can also be compromised, further complicating the recovery process and integration back into daily life (Article, 2014; Surgery, 2020).

Given the potential for cognitive decline post-ATL, there is a pressing need for effective rehabilitation strategies to support cognitive recovery and enhance patient outcomes (Alexandratou et al., 2021). Cognitive rehabilitation, a therapeutic approach designed to improve cognitive function through structured and repetitive tasks, has shown promise in various neurological conditions, including traumatic brain injury and stroke(Barman et al., 2016; Cicerone et al., 2019). However, its application in epilepsy, particularly in post-surgical settings, remains relatively underexplored.

RehaCom, a computerized cognitive rehabilitation software, offers an interactive and engaging platform for cognitive training. It includes a variety of modules targeting specific cognitive domains such as memory, attention, executive functions, and visuospatial skills(Maggio et al., 2023; Pantzartzidou et al., 2017). RehaCom has been utilized successfully in patients with different neurological disorders, demonstrating improvements in cognitive functions and quality of life(Bogdanova et al., 2017). However, there is limited evidence on its effectiveness in patients who have undergone ATL for epilepsy.

The present study aims to address this gap by evaluating the impact of RehaCom cognitive rehabilitation on the neurocognitive status of patients post-ATL. Specifically, we seek to determine whether structured cognitive rehabilitation using RehaCom can mitigate the cognitive deficits typically observed following ATL and promote overall cognitive recovery. By focusing on a comprehensive battery of cognitive assessments, this study aims to provide robust evidence on the potential benefits of cognitive rehabilitation in this patient population. The findings are expected to have significant implications for clinical practice, offering new pathways for improving the cognitive and functional outcomes of this patient population.

## Method

This prospective, interventional study was conducted at Imam Khomeini Hospital from September 2021 to September 2022. The study was designed to evaluate the effectiveness of RehaCom cognitive rehabilitation on neurocognitive functions in patient's post-ATL. All procedures were conducted in accordance with the formal approval of the local human subjects and animal care committees. Ethical approval was obtained from the Institutional Review Board [ethical NO: IR.TUMS.IKHC.REC.1400.132], and all participants provided written informed consent prior to inclusion.

## Participants

The inclusion criteria for participants were: (1) age between 18 and 65 years, (2) literacy sufficient to comprehend and interact with the rehabilitation software, (3) completion of ATL at least two weeks prior to study commencement, (4) absence of degenerative nervous system disorders, and (5) no severe aphasia or other conditions precluding participation in cognitive assessments and rehabilitation. Exclusion criteria included: (1) history of other neurological disorders (e.g., stroke, severe traumatic brain injury), (2) significant psychiatric conditions (e.g., major depressive disorder, schizophrenia), and (3) inability to participate in follow-up assessments.

Based on the study by Fernández et al. (Fernández et al., 2012) and assuming a Type I error ($\alpha$) of 0.05 and a power ($1-\beta$) of 0.8, the required sample size was estimated to be 12 participants.

## Participants training

Prior to the intervention, therapists underwent comprehensive training on the RehaCom software to ensure standardized and effective administration. The training included detailed instructions on module selection, session management, and progress tracking.

Participants engaged in cognitive rehabilitation using RehaCom, which includes modules designed to target various cognitive domains. The intervention protocol consisted of 45-minute sessions, conducted twice weekly, totaling 10 sessions over a five-week period. Modules were selected based on individual cognitive profiles, aiming to address the specific deficits observed in post-ATL patients, particularly in memory, attention, and executive functions. The difficulty levels were adjusted dynamically to match each participant's performance and ensure optimal cognitive engagement by a psychologist.

## Cognitive assessments

Cognitive functions were evaluated at two time points: baseline (pre-rehabilitation) and post-rehabilitation. The assessment included: (1) Wechsler's Digit Span Tests (DSF and DSB) to measure attention and working memory(Wechsler, 1997), (2) Symbol Digit Modalities Test (SDMT) to evaluate processing speed and executive function(Smith, 1973), (3) Rey Auditory Verbal Learning Test (RAVLT) to assess verbal memory, including immediate recall, learning, and delayed recall (Schmidt, 1996), (4) Brief Visuospatial Memory Test-Revised (BVMT-R) to measure figural memory and visuospatial learning(Benedict et al., 1996), (5) Clock Drawing Test (CDT)(Mendez et al., 1992; Sherman et al., 2020) to assess visuospatial abilities and executive function, and (6) Category fluency test (CFT) to evaluate semantic memory(Robert et al., 1998; Troyer et al., 1997), (7)The Raven's Progressive Matrices to assess general intelligence and abstract reasoning was performed at the baseline (pre-rehabilitation).

## Data collection

Data including sociodemographic information, age, gender, ethnicity, and educational level were collected at baseline and managed using in a semi-structured interview. Data entry was double-checked to ensure accuracy.

## Statistical analysis

Cognitive test scores were analyzed using repeated measures ANOVA to evaluate changes in neurocognitive function before and after the RehaCom cognitive rehabilitation program. The model included a within-subjects factor (test) to compare pretest and posttest scores, and a between-subjects factor (ATL side) to assess differences between left and right ATL groups. Interaction effects between test and ATL side were examined to identify potential variations in cognitive improvement across the groups. We used independent t-test for parametric variables, Mann–Whitney *U* tests for continuous non-parametric variables, and chi-square tests for categorical variables to compare the groups (ATL side) at baseline for cognitive assessment tests. Parametric tests were applied for variables meeting normality assumptions, as verified by the Shapiro-Wilk test, while the non-parametric Friedman test was used for variables that did not meet these criteria. Effect sizes were calculated using partial eta squared ($\eta^2$), with statistical significance set at $p < 0.05$.

## Adherence and monitoring

Adherence to the rehabilitation protocol was monitored, with session attendance recorded for each participant. Reasons for any missed sessions were documented and addressed. Participants were encouraged to provide feedback on their experience with the RehaCom software and the rehabilitation process. This feedback was used to make minor adjustments and ensure participant engagement and satisfaction.

## Results

### *Patient characteristics*

The study cohort consisted of 12 patients who underwent anterior temporal lobectomy (ATL), with equal distribution between left and right ATL (6 patients each). The demographic and baseline characteristics of the patients are summarized in **table 1**. The average age of the participants was 34 years (range 22-52 years), and the average IQ, as assessed by Raven's Progressive Matrices, was 92 (range 80-107). There were no significant differences between the groups in terms of age, sex, IQ, or other demographic variables, thereby minimizing the potential influence of these factors as confounders (see **table 1**). included 6 females and 6 males, with 7 participants being married. Only one participant was left-handed, and the rest were right-handed.

### *Cognitive outcomes*

#### Attention and working memory

The Digit Span Backward (Max Length of Correct Responses) showed no significant improvement in the right ATL group ($p$ = 0.375), while the left ATL group demonstrated significant improvement ($p$ = 0.0312). Overall, there was a significant increase in the maximum length of correct responses across both groups ($p$ = 0.011), primarily driven by improvements in the left ATL group (see **figure 1A**). In contrast, the Digit Span Backward (Number of Correct Responses) revealed significant improvements in both the right ATL group ($p$ = 0.025) and the left ATL group ($p$ = 0.014), with an overall highly significant improvement observed across both groups ($p$ = 0.0009). (see **figure 1B**)

#### Verbal memory

The Rey Auditory Verbal Learning Test (RAVLT) demonstrated significant improvements across multiple aspects of verbal memory following rehabilitation.

There was a significant improvement in working memory after rehabilitation ($p$ = *0.0015,* $\eta^2$ = 0.650), with a large effect size indicating strong benefits of the cognitive intervention. A significant difference between the left and right ATL groups was found (p = 0.025), suggesting that the side of the lobectomy affected working memory performance, with one group outperforming the other. The interaction effect was not significant (p = 0.180), indicating that while the two groups differed overall in working memory performance, their patterns of improvement from pretest to posttest were similar (see **figure 2A**).

Learning ability, measured by the number of words recalled over five trials, showed substantial improvement ($p$ < *0.001***,** $\eta^2$ = 0.810), with a large effect size indicating that the rehabilitation greatly enhanced participants' learning capacity. There was a significant difference between the left and right ATL groups ($p$ = 0.009), indicating that the side of the lobectomy influenced learning performance, with one group outperforming the other. The non-significant interaction effect ($p$ = *0.724*) suggests that the learning improvements occurred similarly in both ATL groups, regardless of the side of the lobectomy (see **figure 2B**).

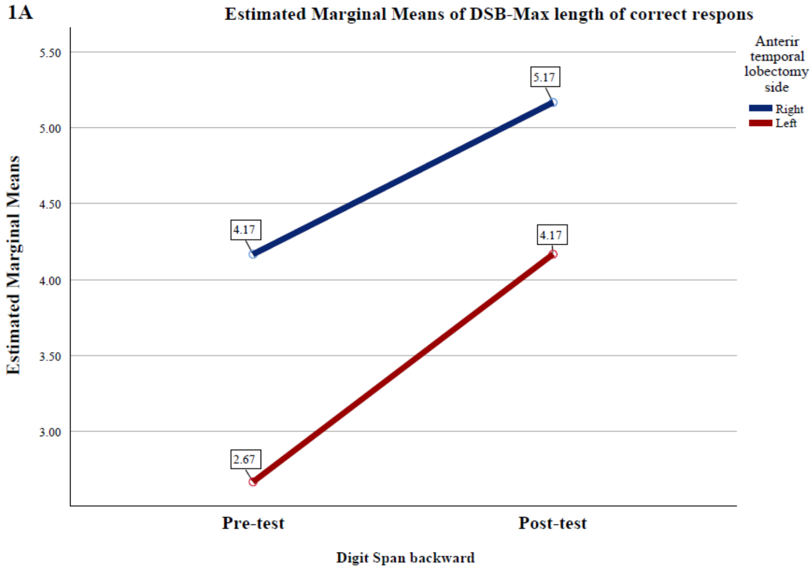
In the RAVLT delayed recall task, no significant improvement was observed in the right ATL group ($p$ = 0.317), whereas the left ATL group demonstrated a significant improvement in delayed recall performance ($p$ = 0.025). Overall, there was a significant improvement across both groups ($p$ = 0.019), with the results largely driven by the substantial gains in the left ATL group. (see **figure 2C**)

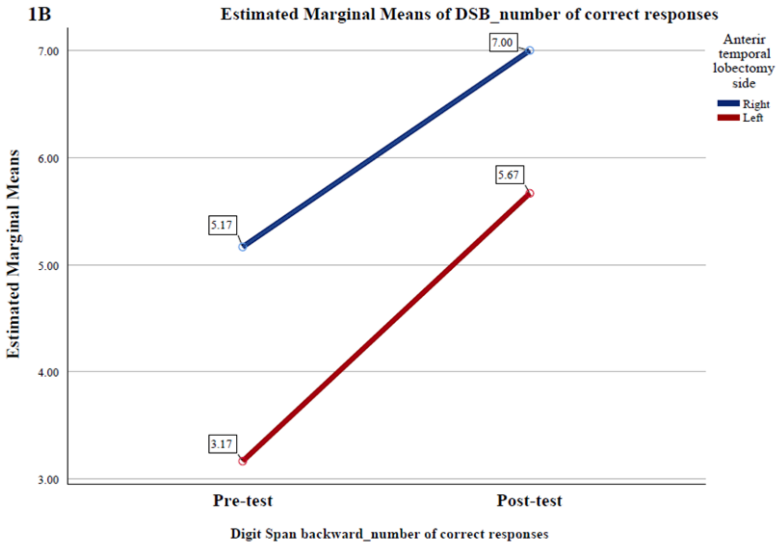
**Table 1.** *Participant Demographic and Clinical Characteristics by ATL Side*

| Variable | Right ATL (n=6) | Left ATL (n=6) | *p-value* |
|---|---|---|---|
| Age, M(SD) | 40.17(9.19) | 28.5(9.48) | 0.056 |
| Sex, n (F/M) | 3/3 | 3/3 | 1.000 |
| Handedness, n (R/L) | 6/0 | 5/1 | 0.296 |
| Marital Status (n, %) | 5(41.7) Married | 2(16.7) Married | 0.078 |
| Psychiatric Disorder (n, %) | 2(16.7) * | 3(25) * | 0.558 |
| Familial History of epilepsy | 0 | 1(8.3) | 0.296 |
| Perinatal insult, n (%) | 0 | 0 | 1.000 |
| History of Developmental Delay, n (%) | 0 | 2(16.7) | 0.121 |
| History of head trauma, n (%) | 0 | 1(8.3) | 0.296 |
| Surgery to test interval(month), M(SD) | 14.83(9.88) | 9(10.17) | 0.338 |
| Education(years), M (SD) | 11.33(3.88) | 12.67(3.72) | 0.557 |
| IQ (Raven test score), M(SD) | 98.33(7.42) | 85.16(14.85) | 0.081 |

*ATL* = anterior temporal lobectomy; *M* = mean; *SD* = standard deviation; *F* = female; *M* = male; *R* = right; *L* = left. *p*-values calculated using independent-samples *t*-test for continuous variables and chi-square test for categorical variables. *: Psychiatric disorder, including mild anxiety disorder that doesn't impair cognition and daily functioning.

**Figure 1.** *Attention and Working Memory*




Performance on the Digit Span Forward task (measured by the maximum length of correct responses) indicated that patients with right anterior temporal lobectomy (ATL) demonstrated less improvement compared to those with left ATL following RehaCom rehabilitation (1A). In contrast, the Digit Span Backward task (number of correct responses) showed significant improvements in both groups, with greater gains observed in the left ATL group (1B).

### Figural memory

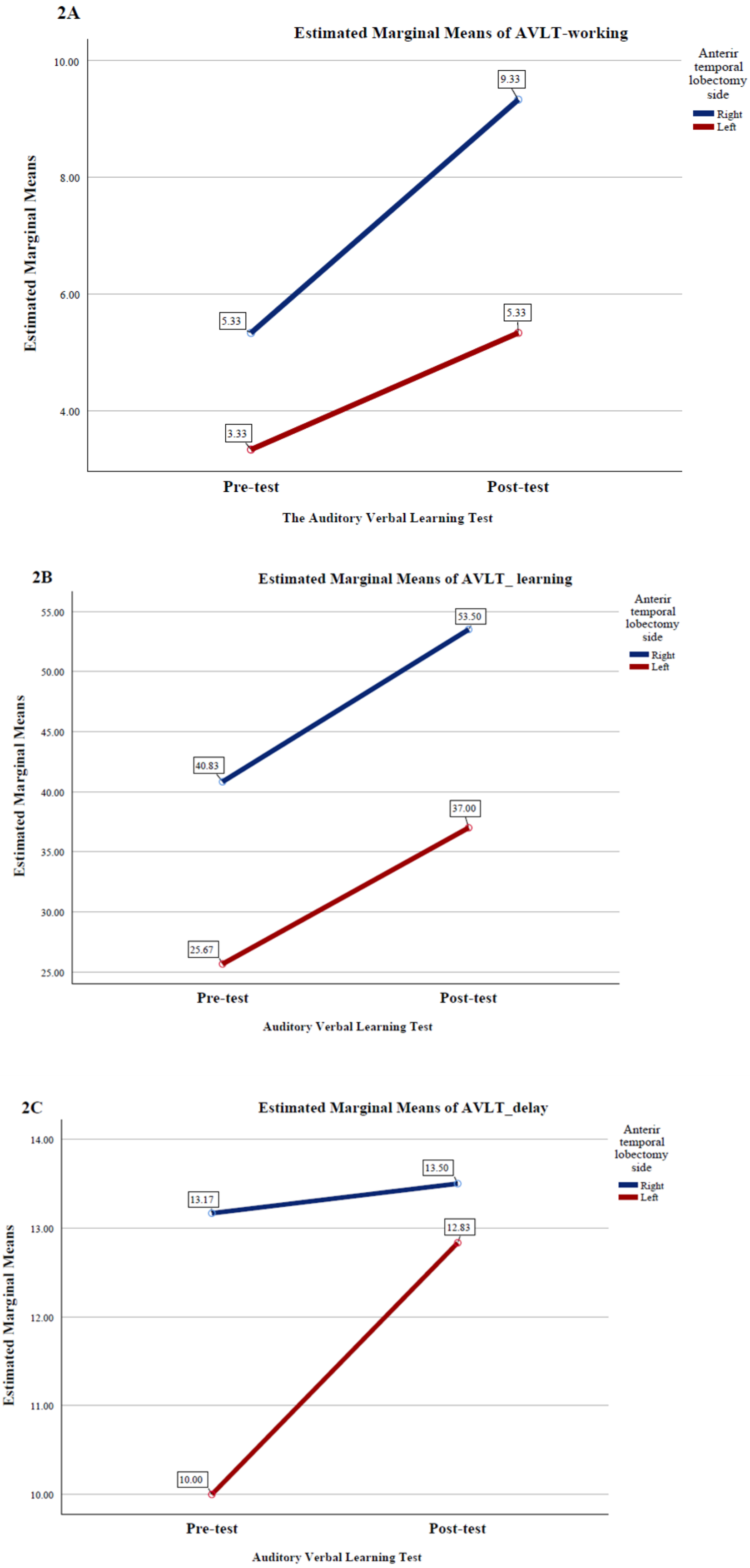
A significant improvement was observed in figural memory from pretest to posttest ($p$ = 0.013, $\eta^2$ = 0.472). The large effect size suggests that the RehaCom cognitive rehabilitation had a substantial impact on participants' visual memory, improving their ability to recall visuospatial information after 10 seconds. There was no significant difference between the left and right ATL groups ($p$ = 0.639), indicating that both groups benefited similarly from rehabilitation. non-significant interaction ($p$ = 0.860) suggests that the pattern of improvement in visual memory was consistent across both groups, meaning that the side of the lobectomy did not influence the degree of improvement over time (see **figure 3A**).

No significant improvement in visual memory after 25 minutes (BVLT-25 min) was observed in the right ATL group ($p$ = 0.083). However, a significant improvement was noted in the left ATL group ($p$ = 0.045). Overall, a significant enhancement in delayed figural memory was observed across both groups (p = 0.008), with the improvement primarily driven by the left ATL group (see **figure 3B**).

### Executive function

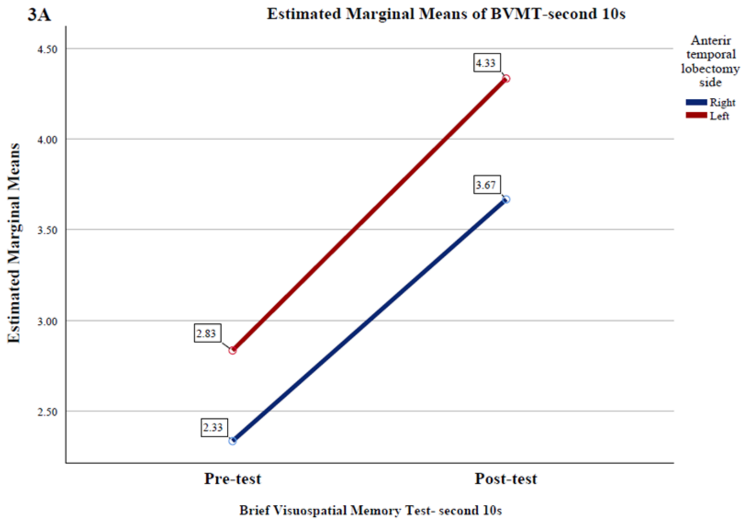
Significant improvement in processing speed and executive function was observed ($p$ = 0.001, $\eta^2$ = 0.672). The large effect size demonstrates a strong impact of rehabilitation on cognitive flexibility and information processing. There was no significant difference between the left and right ATL groups ($p$ = 0.904), indicating that both groups exhibited similar levels of improvement. The lack of a significant interaction effect ($p$ = 1.000) suggests that the improvement in correct responses was uniform across both ATL groups, without any influence from the side of the lobectomy. (see **figure 4**)

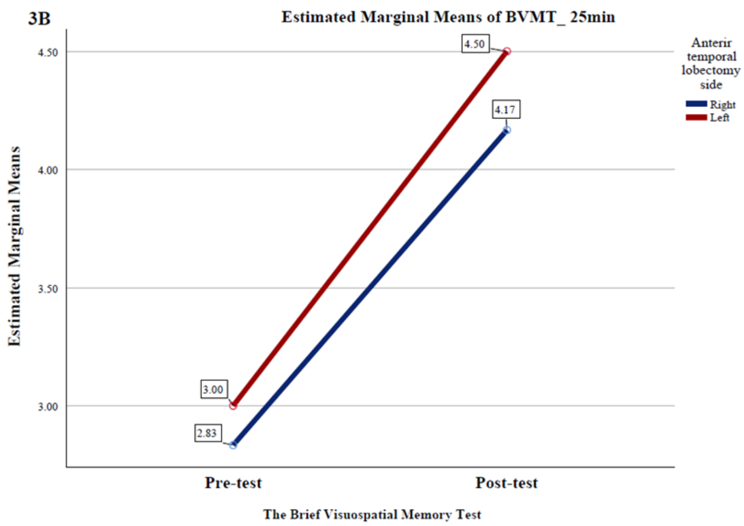
**Figure 2.** *Verbal Memory*




Note. Working memory, assessed using the Rey Auditory Verbal Learning Test (RAVLT) during the first recall of 15 presented words, revealed significant improvement in both groups, with the right ATL group exhibiting superior performance post-rehabilitation (2A). In terms of learning memory, both groups demonstrated substantial improvements (2B). For delayed recall, assessed 30 minutes after the initial presentation, the left ATL group showed more pronounced and statistically significant improvement (2C).

**Figure 3.** *Figural memory*




The Brief Visuospatial Memory Test-Revised (BVMT-R), which involves presenting six geometric figures on a 2x3 grid for a short duration, followed by recall through drawing, showed significant improvement in both groups. Participants demonstrated enhanced recall after 10 seconds (3A) and after a 25-minute delay (3B).

### Semantic memory

Significant improvement was observed in semantic memory and verbal fluency ($p$ = 0.011, $\eta^2$ = 0.487). This large effect size indicates that rehabilitation enhanced participants' ability to access and retrieve verbal information efficiently. No significant difference was found between the left and right ATL groups ($p$ = 0.512), meaning both groups showed similar verbal fluency performance. The non-significant interaction effect ($p$ = 0.904) confirms that the improvement in fluency did not differ based on which side of the brain was affected by surgery. (see **figure 5**)

### Visual-spatial processing

Clock Drawing Test (CDT) showed no significant improvement in either group ($p$ = 1.000 for both), indicating that visuospatial processing, as measured by this test, did not change as a result of the rehabilitation.

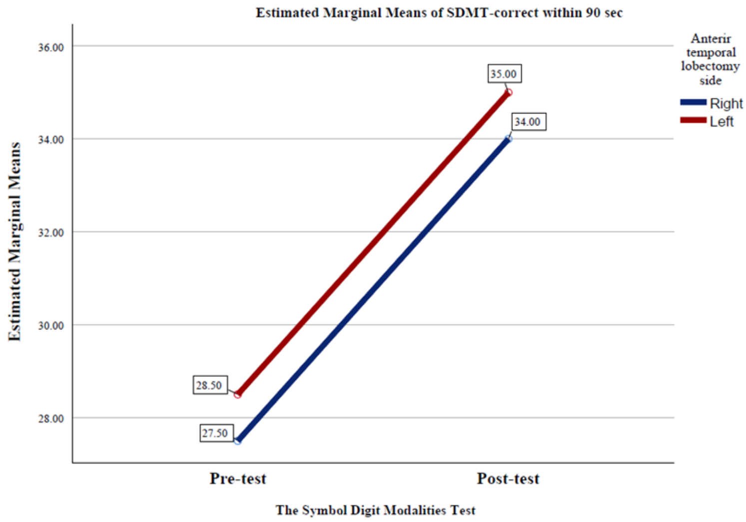
### Comprehensive cognitive improvement

The results demonstrate that RehaCom cognitive rehabilitation significantly improved various cognitive functions, particularly in areas such as working memory, verbal learning, delayed recall, and figural memory. The side of the ATL surgery (left vs. right) had some impact on overall performance in certain memory tasks (e.g., RAVLT working memory and delayed recall), but it did not affect the pattern of improvement from pretest to posttest. These findings suggest that the RehaCom intervention is effective across different cognitive domains and is beneficial regardless of the side of lobectomy, though the left ATL group showed more significant improvements in some memory-related tasks.

### Adherence and feedback

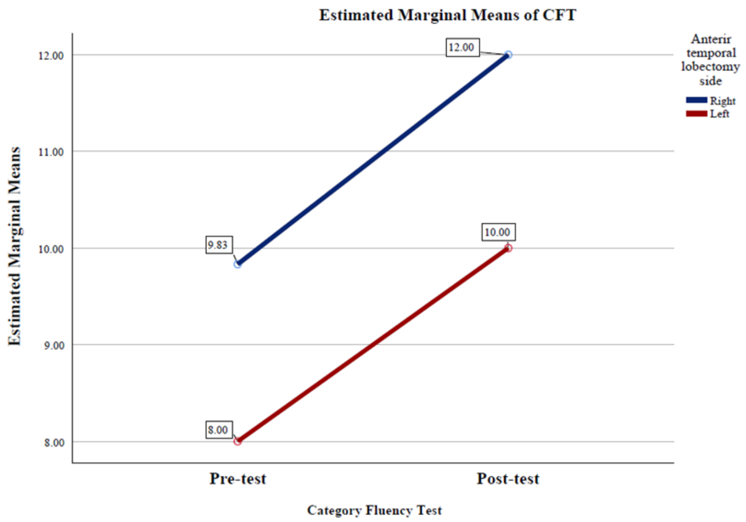
All participants completed the 10-session

**Figure 4.** *Executive function*




In the Symbol Digit Modalities Test (SDMT), where participants match symbols to corresponding digits within a set time frame, both left and right ATL groups exhibited significant and comparable improvements in processing speed and accuracy.

**Figure 5.** *Semantic memory*




The Category Fluency Test (CFT), which assesses semantic memory by requiring participants to generate as many unique words as possible within a specific category in one minute, revealed significant improvements in both groups.

rehabilitation program. Adherence was high, with minimal dropouts and consistent session attendance. Participants reported positive feedback, noting improved cognitive function and daily life activities.

### Statistical analysis

The statistical analyses confirmed significant improvements across multiple cognitive domains. Paired-sample t-tests indicated robust pre-post changes, and effect sizes were calculated to determine the magnitude of these changes. **Table 2** provides detailed statistical results for each cognitive test, including means, standard deviations, t-values, p-values, and effect sizes.

## Discussion

The results of this study demonstrate significant cognitive improvements following RehaCom cognitive rehabilitation in patients who underwent anterior temporal lobectomy (ATL). Marked improvements were observed in multiple domains, including working memory, verbal learning, and delayed recall. Specifically, the RAVLT (working memory) showed a significant overall improvement with a large effect size ($\eta^2 = 0.650$), and similar patterns were observed in RAVLT (learning) with an effect size of $\eta^2 = 0.810$. Delayed recall also exhibited significant gains ($\eta^2 = 0.797$), though these improvements were more pronounced in the left ATL group. Furthermore, both right and left ATL groups demonstrated significant improvements in figural memory and processing speed, as assessed by the Brief Visual Memory Test and Symbol Digit Modalities Test, respectively. These findings suggest that cognitive rehabilitation, regardless of the side of lobectomy, can effectively enhance neurocognitive outcomes, particularly in memory-related tasks.

**Table 2.** *Descriptive statistics for Cognitive Assessment Tests*

| Variable | Pretest | | | | Posttest | | |
|---|---|---|---|---|---|---|---|
| | Right ATL M (SD) | Left ATL M (SD) | *p-value* (right vs left ATL side) | Total M (SD) | Right ATL M (SD) | Left ATL M (SD) | Total M (SD) |
| Brief Visual Memory Test second (10s) | 2.33(2.58) | 2.83(2.13) | 0.449 | 2.58(2.27) | 3.66(2.16) | 4.33(2.06) | 4.00(2.04) |
| Brief Visual Memory Test (25 min) | 2.83(2.48) | 3(1.89) | 0.899 | 2.91(2.10) | 4.16(2.40) | 4.5(2.07) | 4.33(2.14) |
| Symbol Digit Modalities Test _Correct | 27.50(13.86) | 28.50(14.9) | 0.907 | 28.0(13.73) | 34(13.06) | 35(15.40) | 34.50(13.62) |
| Category Fluency Test score | 9.83(5.41) | 8.0(4.14) | 0.525 | 8.91(4.69) | 12.0(5.89) | 10(4.427) | 11(5.08) |
| Digit Span backward_Max length of correct response | 4.166 ( 0.98) | 2.66 (0.816) | **0.025#** | 3.41 (1.16) | 5.16(1.60) | 4.16(0.98) | 4.666(1.37) |
| Digit Span backward_number of correct responses | 5.166(1.72) | 3.166(1.60) | 0.064 | 4.166(1.89) | 7(2.82) | 5.66(2.160) | 6.33(2.49) |
| RAVLT-working memory | 5.33(1.86) | 3.33(2.06) | 0.109 | 4.33(2.14) | 9.33(3.14) | 5.33(1.96) | 7.33(3.25) |
| RAVLT -learning | 40.83 (9.94) | 25.66 (10.53) | **0.028** | 33.25(12.57) | 53.50(5.46) | 37.0(9.52) | 45.25(11.36) |
| RAVLT-delayed recall | 13.16 (0.75) | 10(2.52) | **0.027** | 11.58(2.42) | 13.50(1.22) | 12.83(2.04) | 13.16(1.64) |
| Clock drawing test (R/W total score) | 5(1) | 5(1) | 0.102* | 10(2) | 5(1) | 6(0) | 11(1) |

*M = Mean; SD = Standard deviation; ATL = Anterior Temporal Lobectomy; BVMT-R = Brief Visuospatial Memory Test–Revised; SDMT = Symbol Digit Modalities Test; RAVLT = Rey Auditory Verbal Learning Test.*

*p-values were calculated using independent samples t-tests for continuous parametric variables, Mann–Whitney U tests for non-parametric variables (#), and chi-square tests for categorical variables (*).*

Patients who underwent left ATL, where language and verbal memory are predominantly processed, showed significant improvements in verbal memory following RehaCom rehabilitation. This finding is consistent with Bresson et al. and Jones, who both reported more severe verbal memory impairments after left ATL surgery. In these studies, left ATL patients faced greater challenges with language and memory, but they showed meaningful improvement when targeted rehabilitation strategies were applied(Jones, 1974; Rougier et al., 2007). In contrast, our study not only confirmed these memory improvements for left ATL patients but also showed that right ATL patients benefited in different areas, such as figural memory, attention, and executive function.

In contrast to the findings of Helmstaedter et al. (2008), which reported limited improvements in verbal memory for left lobectomy patients compared to those with right lobectomy, our study demonstrates that RehaCom cognitive rehabilitation effectively addresses these limitations. Our results show significant improvements in verbal memory for patients with left-sided lobectomy, surpassing the outcomes observed in Helmstaedter's study. Additionally, RehaCom proved beneficial in enhancing both attention and figural memory, cognitive domains where Helmstaedter et al. found no significant improvements following rehabilitation. This suggests that RehaCom provides a more comprehensive approach to cognitive recovery in post-lobectomy patients, particularly for those with left-sided resections(Helmstaedter et al., 2008).

Koorenhof et al. examined the effects of a rehabilitation program (Lumosity) on verbal memory improvement in patients undergoing left temporal lobectomy for epilepsy, comparing the impact of rehabilitation administered both before and after surgery. Although the rehabilitation program led to overall improvements in verbal memory, the timing of the intervention—whether conducted pre- or postoperatively—did not significantly influence the outcomes. Our study similarly observed significant improvements in verbal memory in left lobectomy patients, consistent with Koorenhof et al.'s findings, indicating that the timing of rehabilitation may not be a critical factor in enhancing verbal memory performance, as previously suggested for further investigation by Helmstaedter et al. (Felice et al., 2017). Right ATL patients in our study showed pronounced gains in figural and verbal memory, which was not a focus in Koorenhof's study, underscoring the importance of tailoring cognitive rehabilitation to the specific deficits caused by the side of surgery.

The studies examined rehabilitation in patients with epilepsy who had not undergone lobectomy and found significant improvements in memory following rehabilitation. Specifically, the group-based memory training assessed by Radford et al. and the cognitive remediation approach utilized by Anuradha et al. demonstrated beneficial effects on memory recovery in this cohort of epilepsy patients (Anuradha et al., 2013;

Radford et al., 2011).

Similarly, the findings of Caller et al. and Kerr & Blackwell, who focused on interventions aimed at improving memory and working memory, confirm the value of structured cognitive rehabilitation. However, these studies did not account for differences in cognitive recovery based on surgery side(Caller et al., 2015; Kerr & Blackwell, 2015). In the current study, right ATL patients showed significant improvements, suggesting that RehaCom's multi-domain approach is especially beneficial for addressing non-verbal deficits typically associated with right ATL surgery. This highlights the program's adaptability in addressing the full range of cognitive impairments following epilepsy surgery.

The results demonstrate that RehaCom is an effective tool for enhancing cognitive outcomes across multiple domains, regardless of whether patients underwent left or right ATL. The improvements observed in verbal memory for left ATL patients and in figural memory, attention, and executive function for right ATL patients highlight the value of individualized, adaptive rehabilitation tools that target the specific deficits resulting from surgery.

In conclusion, this study provides robust evidence that RehaCom cognitive rehabilitation significantly enhances neurocognitive outcomes in epilepsy patients following ATL. The improvements in memory, attention, and executive function, regardless of the surgery side, demonstrate the program's adaptability and effectiveness. These findings support the integration of individualized, multi-domain cognitive rehabilitation programs into standard post-surgical care to promote comprehensive cognitive recovery and improve overall quality of life for epilepsy patients.

## Limitations and future directions

However, the study has limitations. The relatively small sample size and single-center design may limit the generalizability of the findings. Additionally, the absence of a control group and pre-surgical cognitive assessments makes it challenging to attribute cognitive improvements solely to the RehaCom program. Future studies should include larger, multicenter trials with control groups to validate these findings and further explore the mechanisms underlying cognitive recovery in TLE patients post-ATL.

Future research should also investigate the differential effects of RehaCom on left versus right ATL patients, providing further insights into the lateralization

**Table 3.** *Summary of two-way repeated measures anova for parametric cognitive outcomes*

| Variables(parametric) | Effect | F(df) | *p-value* | Partial η² |
|---|---|---|---|---|
| Brief Visual Memory Test second (10s) | Side (ATL) | 0.23(1,10) | p = .639 | 0.023 |
| | Test | 8.97(1,10) | p = .013 | 0.473 |
| | Test * side (interaction) | 0.03(1,10) | p = .864 | 0.003 |
| Symbol Digit Modalities Test _(Correct) | Side (ATL) | 0.015(1,10) | p = .905 | 0.002 |
| | Test | 20.52(1,10) | p = .001 | 0.672 |
| | Test * side (interaction) | 0.00(1,10) | p = 1.000 | 0.000 |
| Category Fluency Test (score) | Side (ATL) | 0.462(1,10) | p = .512 | 0.044 |
| | Test | 9.49(1,10) | p = .012 | 0.487 |
| | Test * side (interaction) | 0.015(1,10) | p = .904 | 0.002 |
| RAVLT- working memory | Side (ATL) | 6.89(1,10) | p = .025 | 0.408 |
| | Test | 18.62(1,10) | p = .002 | 0.651 |
| | Test * side (interaction) | 2.06(1,10) | p = .181 | 0.171 |
| RAVLT- learning | Side (ATL) | 10.36(1,10) | p = .009 | 0.509 |
| | Test | 42.70(1,10) | <0.001 | 0.810 |
| | Test * side (interaction) | 0.13(1,10) | p = .724 | 0.013 |

*F(df)* = F-value and degrees of freedom for each effect. *ATL* = anterior temporal lobectomy; *RAVLT* = Rey Auditory Verbal Learning Test; *Partial η²* = effect size estimate. *p-values* refer to main and interaction effects from the two-way repeated measures ANOVA.

**Table 4.** *Summary of friedman test results for non-parametric cognitive outcomes*

| Measure | ATL side | | |
|---|---|---|---|
| | right ATL *P-value* | left ATL *P-value* | *P-value* |
| Brief Visual Memory Test (25 min) | 0.083 | 0.045 | 0.008 |
| Digit Span Backward-Max length of correct response | 0.375 | 0.0312 | 0.011 |
| Digit Span Backward-Number of correct responses | 0.025 | 0.014 | 0.0009 |
| RAVLT-delayed recall | 0.317 | 0.025 | 0.019 |
| Clock drawing test | 1.000 | 1.000 | 1.000 |

*ATL* = anterior temporal lobectomy; *RAVLT* = Rey Auditory Verbal Learning Test; *p* values reflect results from non-parametric test (Friedman).

of cognitive functions and rehabilitation outcomes. Exploring the impact of individualized rehabilitation plans based on specific cognitive profiles could optimize intervention strategies. Moreover, combining RehaCom with other therapeutic modalities, such as pharmacotherapy or physical rehabilitation, might yield synergistic benefits. Assessing the cost-effectiveness of integrating cognitive rehabilitation into routine postoperative care is also crucial for understanding its value comprehensively.

## Conclusion

In conclusion, our study demonstrates that RehaCom cognitive rehabilitation significantly enhances neurocognitive functions in post-ATL patients. The observed improvements in attention, memory, and executive function underscore RehaCom's efficacy as a postoperative intervention. These findings support the incorporation of cognitive rehabilitation into standard care for ATL patients, promoting better cognitive health and quality of life. Further research with larger samples and extended follow-up periods is warranted to confirm these findings and explore additional cognitive domains.

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