MEMORY LATERALIZATION IN SPANISH-SPEAKING ADULTS WITH TEMPORAL LOBE EPILEPSY: A PILOT STUDY

A DISSERTATION PROPOSAL SUBMITTED TO THE FACULTY

OF

PSY.D. (DOCTOR OF PSYCHOLOGY) PROGRAM IN CLINICAL PSYCHOLOGY

OF

OF WILLIAM PATERSON UNIVERSITY OF NEW JERSEY

BY

SOFIA MAGEE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF

DOCTOR OF PSYCHOLOGY

APPROVED

[DIPLOMA DATE]

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Abstract

Presurgical workups for epilepsy usually include neuropsychological evaluations and, at times, a Wada procedure. This study sought to investigate the lateralization trends of visual and verbal memory while using Wada lateralization information of Spanish-speaking presurgical candidates with temporal lobe epilepsy. Based on previous findings, it was predicted that verbal memory performance would be associated with left temporal lobe functioning and that visual memory performance would not lateralize. Archival data collected at a major urban hospital from 2001 to 2019 was analyzed using inferential statistical tests. Contrary to predictions, there were no associations between verbal/visual memory and hemispheric functioning as seen through 1) the presence of left or right temporal lobe epilepsy and 2) hemispheric memory dominance determined by Wada memory scores. The results of this study suggest that memory type might not lateralize as strongly as expected in Spanish-speaking individuals with temporal lobe epilepsy, which could have implications on this population's presurgical evaluations for epilepsy.

Memory Lateralization in Spanish-Speaking Adults with Temporal Lobe Epilepsy: A Pilot Study

Epilepsy is a chronic neurological disease that affects around 70 million people globally, approximately 1% of the world's population (Fisher et al., 2014). This disease is characterized by a predisposition for spontaneous seizures due to neuronal overactivation of the brain, which are most often attributed to genetics (Helbig et al., 2008) or the presence of structural brain abnormalities (Berg et al., 2009). Epilepsy is associated with characteristic changes in an individual's neurobiology, cognitive abilities, and sociopsychology. As such, epilepsy can lead to restrictions on activities of daily living, decreased health, and an overall increased mortality rate, as compared to healthy controls (Mbizvo et al., 2019).

The current first-line treatment for epilepsy is antiseizure medication which, on its own, is effective for approximately 66% of individuals (Duncan et al., 2006). Individuals who fail to benefit from antiseizure medications account for one third of individuals with the illness (Kwan et al., 2010) and are classified as 'drug-resistant.' Surgical treatment is the most common intervention for drug-resistant individuals, and it commonly involves the removal or disconnection of a brain area, most often the seizure onset site. Postsurgical effectiveness rates, in which all seizures or the most severe type of seizures cease, range from 50 to 80% (Ryvlin et al., 2014).

Prior to surgery, multidisciplinary evaluations involve determining the epileptogenic zone using video electroencephalogram (vEEG) and magnetic resonance imaging (MRI), as well as the estimation of potential postsurgical deficits. Neuropsychologists are often involved in presurgical evaluations to assess the cognitive risk factors associated with the procedure. Neuropsychological assessment for presurgical evaluations includes standard neuropsychological assessment and, in some cases, intracarotid sodium amobarbital (Wada) testing (Andelman et al., 2004). The Wada procedure involves the injection of sodium amobarbital into the carotid arteries to temporarily impair functioning of the ipsilateral cerebral hemisphere. The Wada test allows for lateralization of speech dominance and assessment of memory performance on both cerebral hemispheres, which is most commonly used among presurgical candidates who have temporal lobe epilepsy (TLE; Milner, 1962).

A standard neuropsychological assessment can provide useful information regarding localization and lateralization of brain lesion(s) and the degree of current and predicted postsurgical cognitive functioning. Impaired language and memory performance on one hemisphere might indicate pathology and, therefore, a potential epileptogenic zone that, if removed, has high likelihood of postsurgical success (Loring et al., 1994; Loring & Meador, 2009; Mohan et al., 2018; Ryvlin et al., 2014).

Cognitive deficits are commonly seen in patients with epilepsy, which have been attributed to multiple causes, including epileptic discharges, brain lesions, and antiepileptic medications (Eddy et al., 2011; Meador et al., 2007; Witt & Helmstaedter, 2013). The progression of cognitive decline has been associated with seizure duration (Helmstaedter & Elger, 2009), cognitive reserve (Oyegbile et al., 2004), and onset of the disorder. For example, individuals with childhood onset epilepsy are at an increased risk for learning disabilities (Braakman et al., 2012). A review of imaging studies suggests that epilepsy is associated with volume loss of the epileptogenic zone, as well as network areas (Braakman et al., 2012). In fact, there is much consensus that epilepsy is a neurological network disorder (Bartolomei et al., 2017), meaning that the effects of epileptic seizures can be noted in the seizure focus as well as in distant areas. Individuals with TLE have been shown to have greater memory impairments (Trenerry et al., 1993; Baxendale et al., 2008), which has been associated with the atrophy of several brain regions including the hippocampus (Baxendale et al., 2008), the amygdala (Kälviäinen et al., 1998), the thalamus (Seidenberg et al., 2008), and the mammillary bodies (Martin et al., 1999).

Until recently, the material-specific memory model was widely accepted, which suggested that left temporal lesions lead to verbal memory impairments while right temporal lesions lead to visual memory impairments (Milner, 2000; Novelly et al., 1984). Currently, research studies are more supportive of the association between verbal memory performance and left hemisphere functioning, which within epileptic samples has been seen through reduced verbal memory performance among individuals with left TLE (LTLE). The relationship between reduced visual memory performance and right TLE (RTLE) has remained inconsistent (Alpherts et al., 2006; Rausch et al., 2003; Gleiβner et al., 1998). This pattern of results has been frequently reported in Wada results by showing a strong relationship between left memory dominance and verbal memory scores (Hanoglu et al., 2013; Vingerhoets et al., 2006). Moreover, Wada results have also suggested that the relationship between visual memory and right memory dominance is more unclear with some showing a positive correlation (Delaney et al., 1980; Ivnik et al., 1988) and others no association (Hanoglu et al., 2013; Vingerhoets et al., 2006). Therefore, a more current view is that verbal memory is more closely associated with left hemisphere functioning while visual memory does not lateralize.

While the relationship between Wada and standard neuropsychological memory scores has been extensively studied in English-speaking adults with TLE, there is a paucity of information on this topic among Spanish-speaking individuals, and specifically while using the Neuropsychological Screening Battery for Hispanics (NeSBHIS). The NeSBHIS is a neuropsychological battery developed by Pontón et al. (1996) to ensure the use of appropriate norms and assessments with Hispanic individuals. Research has shown that the NeSBHIS is sensitive at detecting cognitive deficits common among individuals with epilepsy (Barr et al., 2009; Bender et al., 2009). Moreover, similarly to the English-speaking samples, research using the NeSBHIS has shown lower verbal memory performance among those with LTLE (Smith et al., 2020). This study aims to understand the relationship between Wada memory scores and NeSBHIS memory neuropsychological results among Spanish-speaking individuals with TLE. To date, we are not aware of any other study that has looked at the lateralization trends of NeSBHIS memory measures and its association with Wada memory dominance.

The Current Study

The aim of the current study is to tighten the gap between what is known about Wada and neuropsychological performance in Spanish speaking individuals with TLE.

Several specific hypotheses were tested. First, Spanish-speaking people with LTLE were predicted to have higher rates of verbal memory impairments, as measured by the WHO-UCLA Auditory Verbal Learning Test (AVLT), than people with RTLE. However, it was predicted that there would be no differences between visual memory performance, as measured by the Rey-Osterreith Complex Figure Test (ROCFT), among Spanish-speaking people with RTLE and LTLE. This prediction was made based on previous research on both English- and Spanish-speaking individuals with TLE. The third hypothesis states that individuals with bilateral TLE (BTLE) would not differ in their performance on verbal and visual memory tests. Given that seizure onset source and brain lesions can impair functioning related to the respective brain area, the fourth hypothesis was that memory dominance, as determined by Wada Memory Asymmetry (WMA; Alpherts et al., 2000), would be associated with the hemisphere contralateral to seizure focus (vEEG) and lesion (MRI). Fifth, Spanish-speaking people with left memory dominance, as measured by WMAs, were predicted to show better performance on verbal memory than people with right memory dominance. On the other hand, there would be no differences expected between visual memory performance among Spanish-speaking people with right and left memory dominance. Finally, given the expected strength of association between visual memory and left hemisphere performance, it was hypothesized that visual memory performance alone would be able to predict WMA.

Methods

Participants

The study included archival data from 57 Spanish-speaking adults, born in Spanish-speaking regions of the world (i.e., Argentina, Bolivia, Colombia, Dominican Republic, Ecuador, El Salvador, Honduras, Mexico, Paraguay, Puerto Rico, Venezuela), who had a diagnosis of epilepsy as determined through vEEG monitoring and a standard neurological exam. These individuals were presurgical epilepsy candidates at the New York University (NYU) Comprehensive Epilepsy Center between 2001 and 2019. Both the neuropsychological evaluation and the Wada test were conducted in Spanish by bilingual examiners. Exclusion criteria included the presence of a progressive neurodegenerative or neurologic illness and current psychiatric episode with psychotic features.

Although some cultural differences between Spanish speaking countries have been noted (e.g., differences in education, oral speech production, knowledge of “Americanisms”; Ardila, 2020), they are not expected to result in appreciable differences on neuropsychological testing.

Procedures

The present study consisted on the use of retrospective data from the NYU Comprehensive Epilepsy Center Neuropsychology Research Database and was approved by the

NYU Langone Health Institutional Review Board and the host university's Institutional Review Board.

Neuropsychological evaluations consisted of one or two sessions lasting approximately 90 - 120 minutes each. Administration and scoring of assessments was performed by bilingual examiners (i.e., English and Spanish) who had at least some graduate training in neuropsychological assessment. With the involvement of a multidisciplinary medical team (i.e., neuroradiologists, neurologists, neuropsychologists), the Wada test involved the injection of sodium amobarbital into the carotid arteries that resulted in the impairment of functioning of the ipsilateral cerebral hemisphere. This allowed examiners to measure language and memory functioning of one single hemisphere. After testing was completed on one hemisphere and anesthetic effects had ended, the same procedure was conducted on the other hemisphere.

Measures

The NeSBHIS (Pontón et al., 1996) was administered to the study participants. This battery has been shown to have robust construct validity on general population samples (Pontón et al., 2000) and neurological samples (Bender et al., 2009). This battery has also been shown to have diagnostic validity to determine cognitive impairments in people with epilepsy (Barr et al., 2009). Relevant memory measures from the NeSBHIS included the ROCFT and the WHO-UCLA AVLT. Recall scores of the ROCFT were used as a measure of visual memory and the WHO-UCLA AVLT short delay recall, long delay recall, and recognition scores were used as a measure of verbal memory. Moreover, the Raven Standard Progressive Matrices (RSPM) test was administered to measure nonverbal abstract reasoning and provide an estimate of premorbid intellectual functioning. Results from these assessments were normed using the normative data from the NeSBHIS (Pontón et al., 1996), which were derived from a sample of 342 participants from Spanish-speaking countries who were living in Los Angeles and had widely ranging ages (16-75) and years of education (1-20 years).

The Wada test protocol developed by NYU Langone includes different sections for word and sentence repetition, comprehension of simple and complex commands (e.g., “open your mouth;” “point to the large green square”), confrontation naming (8 objects and 4 pictures), recall of test stimuli, and recognition of test stimuli (18 objects, 14 pictures including test objects and distracters). Wada Memory Asymmetries (WMAs) were calculated by subtracting the right hemisphere Wada memory scores minus the left hemisphere Wada memory scores. A positive WMA score indicates memory dysfunction on the left temporal lobe, while a negative score indicates memory dysfunction in the right temporal lobe (Loring et al., 2009).

Statistical Analysis

First, the sample was tested for demographic and disease-specific differences between those with LTLE (N = 28) and RTLE (N = 19) through t-test and chi-square analyses. Any differences would have been included as covariates in a multivariate analysis of covariance (MANCOVA), with TLE hemisphere as the independent variable. To test for potential differences between LTLE and RTLE groups on memory measures, T-test analyses and a Mann-Whitney U test were conducted. To test for potential differences in verbal and visual memory among those with BTLE, a paired samples t-test was conducted. To test for potential relationships between hemisphere memory dominance and seizure hemisphere onset, as determined by vEEG, and between hemisphere memory dominance and brain lesion(s), as determined by MRI findings, one sample binomial tests were used. To test for potential differences on memory measures between those with left and right memory dominance, t-test analyses and a Mann-Whitney U test were conducted. To analyze the predictive ability of the

NeSBHIS verbal memory measure (i.e., WHO-UCLA AVLT) on hemispheric memory dominance simple logistic regressions would have been used. Non-parametric tests were used to analyze from variables that were not normally distributed, as suggested by Shapiro-Wilk tests.

Results

Demographic and epilepsy-related characteristics were compared through t-test and chi-square analyses between those with left and right temporal lobe epilepsy. No demographic differences were found in terms of age, education, premorbid estimate, sex, region of origin, or handedness (Table 1). There were also no differences found in terms of age of onset or number of antiseizure medications. There was a marginally significant difference in disease duration $t(45) = -1.88$, $p = .067$ with those with RTLE ($M = 25.68$, $SD = 13.74$) having longer disease duration than those with LTLE ($M = 18.54$, $SD = 12.18$) (Table 2). Although there were marginal differences in seizure duration between the TLE groups and there were some correlations between seizure duration, education, and visual memory for the overall sample, adding these variables as covariates did not change the nature of the results of the proposed hypotheses.

Table 1
Sample characteristics for 47 Spanish-speaking patients undergoing neuropsychological and Wada testing with left or right temporal lobe epilepsy.

	LTLE (N = 28)	**RTLE (N = 19)**	
	Mean (SD)	**Mean (SD)**	**p-value**
Age (years)	36.46 (10.47)	38.42 (11.20)	.544
Education (years)	12.32 (3.80)	12.26 (3.71)	.959
Premorbid estimate (raw)	30.96 (13.25)	31.11 (15.45)	.973
Premorbid estimate (z-score)	-.70 (1.02)	-.65 (1.20)	.874
	N (%)	**N (%)**	

Sex			
Female	19 (40%)	10 (21%)	.292
Male	9 (19%)	9 (19%)	
Region of origin			
Bolivia	0 (0%)	2 (4%)	.448
Colombia	5 (10%)	2 (4%)	
Dominican Republic	6 (12%)	1 (2%)	
Ecuador	3 (6%)	2 (4%)	
El Salvador	1 (2%)	1 (2%)	
Mexico	1 (2%)	1 (2%)	
Puerto Rico	10 (21%)	8 (17%)	
Other	2 (4%)	2 (4%)	
Handedness (right)	23 (49%)	17 (36%)	.488

Table 2

Disease-specific characteristics for 47 Spanish-speaking individuals with left or right temporal lobe epilepsy.

	LTLE (N = 28)	**RTLE (N = 19)***	
	Mean (SD)	**Mean (SD)**	**p-value**
Age of onset (years)	17.6 (13.13)	12.79 (13.46)	.229
Seizure duration (years)	18.54 (12.18)	25.68 (13.74)	.067
	N	**N**	**p-value**
Number of ASMs			
Monotherapy	4	1	.634
Polytherapy	24	17	

Note: ASMs = Antiseizure medications.

Because the present study was comprised of a small sample (N = 57), understanding variable distribution was essential. Shapiro-Wilk tests showed that WHO AVLT Recognition was not normally distributed (W = .876, p < .001). Therefore, non-parametric tests were used to analyze data from that variable.

To test the first hypothesis that patients with LTLE would have lower verbal memory performance than those with RTLE, two t-tests and a Mann-Whitney U test were conducted. Specifically, the tests analyzed the differences between individuals with left and right temporal lobe epilepsy on WHO-AVLT Short Delay, Long Delay, and Recognition, respectively. Individuals with LTLE (*M* = 10.21, *SD* = 2.50) and RTLE (*M* = 9.42, *SD* = 2.57) did not significantly differ on their performance on WHO-AVLT Short Delay $t(45) = 1.06$, $p = .297$. Similarly, individuals with LTLE (*M* = 7.57, *SD* = 3.46) and RTLE (*M* = 7.89, *SD* = 2.73) did not significantly differ on their performance on WHO-AVLT Long Delay $t(45) = 1.19$, $p = .734$. A Mann-Whitney U test did not show significant differences on WHO-AVLT Recognition scores between LTLE (*M* = 13.06, *SD* = 1.85) and RTLE (*M* = 12.81, *SD* = 2.26) individuals ($Z = -.254$, $p = .800$).

To test the second hypothesis that there would be no differences in visual memory performance between patients with LTLE and RTLE, a t-test was conducted. This analysis showed that individuals with LTLE (*M* = 11.08, *SD* = 7.83) and RTLE (*M* = 9.05, *SD* = 5.78) did not significantly differ on their performance on RCFT Long Delay $t(44) = .957$, $p = .344$ (See Table 3). In summary, no differences in verbal or visual memory performance were found between individuals with LTLE and RTLE.

Table 3

Neuropsychological performance of individuals with LTE or RTLE.

	LTLE		**RTLE**		
	N	**Mean (SD)**	**N**	**Mean (SD)**	**p-value**
AVLT Short Delay	28	10.21 (2.50)	19	9.42 (2.57)	.297
AVLT Long Delay	28	7.57 (3.46)	19	7.89 (2.73)	.734
AVLT Recognition	26	13.06 (1.85)	17	12.81 (2.26)	.800
RCFT Long Delay	27	11.08 (7.83)	19	9.05 (5.78)	.344

Note: AVLT= WHO-UCLA Auditory Verbal Learning Test; RCFT= Rey-Osterrieth Complex Figure Test.

To test the hypothesis that patients with bilateral TLE (N = 10) would not differ in their performance on verbal and visual memory, a paired samples t-test was conducted. Results indicated that there was no significant difference between AVLT Long Delay (M = -2.03, SD = 1.96) and RCFT Long Delay (M = -1.21, SD = 1.31), $t(9) = -1.06$, p = .316 for individuals with bilateral temporal lobe epilepsy.

To test the fourth hypothesis that hemispheric memory dominance would be negatively associated with seizure focus and brain lesion, one sample binomial tests were conducted. The analyses examined the relationship between vEEG seizure focus and MRI lesion with lateralization of memory dominance (Table 4) to a hypothesized no difference relationship. No difference was found between left seizure focus and memory dominance (p = .845). Right vEEG focus was only associated with left memory dominance. Individuals with left hemisphere lesions did not differ on memory dominance lateralization (p = .210). All individuals with right brain lesions exhibited left memory dominance (See Table 4). Figure 1 shows the distribution of LTLE and RTLE WMA scores.

Table 4

Seizure focus and lesion among individuals with left/right temporal lobe epilepsy.

	Left Memory Dominance N	**Right Memory Dominance N**	**p-value**
vEEG Focus			
Left	12	14	.845
Right	19	0	[a]
MRI Lesion			
Left	5	11	.210
Right	11	0	[a]

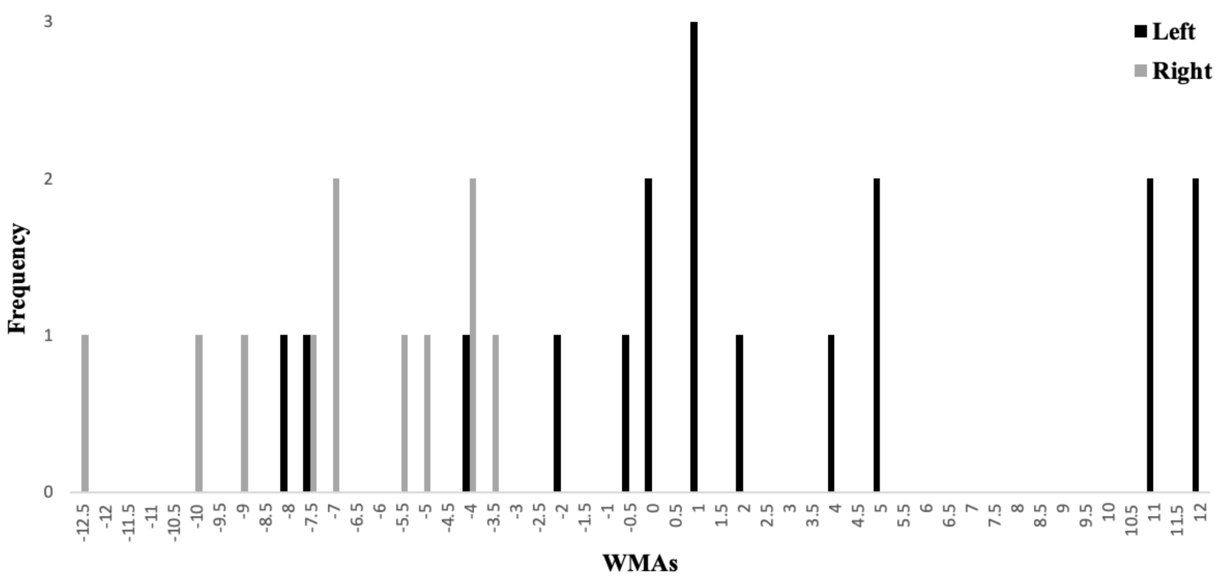
Note: Number of individuals with left or right memory dominance who have seizure focus (vEEG) on the left/right and brain lesions (MRI) on the left/right.

vEEG=Video Electroencephalogram; MRI=Magnetic Resonance Imaging.

[a]Analysis could not be completed because there was zero variability between the groups.

Figure 1

Frequency histogram of LTLE and RTLE WMAs.



Note: The number of individuals with RTLE (grey) and LTLE (black) are represented across a memory dominance spectrum. Negative WMAs reflect right memory dominance, while positive WMAs reflect left memory dominance.

To test the fifth hypothesis that patients with left memory dominance would show better performance on verbal memory measures than patients with right memory dominance, two t-tests and a Mann-Whitney U test were conducted. Specifically, the tests analyzed the differences between left and right memory dominance on WHO-AVLT Short Delay, Long Delay, and Recognition measures, respectively. Individuals with left memory dominance (M = 9.81, SD = 2.57) and right memory dominance (M = 9.93, SD = 2.67) did not significantly differ on their performance on WHO-AVLT Short Delay *t*(43) = -.146, *p* = .885. Similarly, individuals with left memory dominance (*M* = 7.90, *SD* = 3.08) and right memory dominance (*M* = 7.14, *SD* = 3.57) did not significantly differ on their performance on WHO-AVLT Long Delay *t*(43) = .730, *p* = .470. A Mann-Whitney U test did not show significant differences in WHO-AVLT Recognition scores between individuals with left memory dominance (*M* = 13.03, *SD* = 1.80) and right memory dominance (*M* = 12.64, *SD* = 2.65; *Z* = -.146, *p* = .884).

To test that there would be no differences between visual memory performance among patients with right memory dominance and with left memory dominance, a t-test was conducted. The analysis showed that individuals with left memory dominance (*M* = 9.84, *SD* = 6.68) and right memory dominance (*M* = 11.05, *SD* = 8.28) did not significantly differ on their performance on RCFT Long Delay *t*(42) = -.333, *p* = .613 (See Table 5).

Table 5

Neuropsychological performance of individuals with left and right memory dominance.

	Left Memory Dominance		**Right Memory Dominance**		
	N	**Mean (SD)**	**N**	**Mean (SD)**	**p-value**
AVLT Short Delay	31	9.81 (2.57)	14	9.93 (2.67)	.885
AVLT Long Delay	31	7.90 (3.08)	14	7.14 (3.57)	.470
AVLT Recognition	29	13.03 (1.80)	14	12.64 (2.65)	.884
RCFT Long Delay	31	9.84 (6.68)	13	11.05 (8.28)	.613

Note: AVLT= WHO-UCLA Auditory Verbal Learning Test; RCFT= Rey-Osterrieth Complex Figure Test.

The final hypothesis that stated that verbal memory performance could predict hemispheric memory dominance would have been analyzed through a regression analysis.

However, this analysis was not conducted due to a lack of statistical differences found among verbal memory measures and type of epilepsy/memory dominance lateralization.

Discussion

This study sought to investigate several detailed hypotheses relevant to the relationship between temporal lobe functioning and visual and verbal memory while using Wada lateralization information of Spanish-speaking individuals with TLE. The goal of this study was to specifically investigate memory type (i.e., verbal, visual) and their lateralization trends among Spanish-speaking individuals with TLE. It was predicted that verbal memory performance would be associated with left temporal lobe functioning and that visual memory performance would not lateralize.

Results showed no visual memory performance differences between participants with RTLE and LTLE, which reflects current findings on Spanish- (Smith et al., 2020) and English-speaking individuals (Alpherts et al., 2006; Rausch et al., 2003; Gleiβner et al., 1998). Nevertheless, and contrary to previous research on Spanish- (Smith et al., 2020) and English-speaking individuals (Alpherts et al., 2006; Rausch et al., 2003; Gleiβner et al., 1998), results of the current study with Spanish speakers did not indicate that those with LTLE have higher rates of verbal memory impairments than those with RTLE. It is unclear why the current study yielded these results, but other research had shown similar trends in which the NeSBHIS verbal memory task WHO-UCLA AVLT had not been effective in lateralizing individuals with TLE (Barr et al., 2009).

Results also showed that memory dominance, as measured by the Wada test was associated with seizure focus (vEEG) and lesion (MRI) among individuals with RTLE, in such a way that individuals with right temporal lobe lesions and/or seizure focus were more likely to have left hemisphere memory dominance. Of note, the current study sample of individuals with LTLE showed a wide distribution on their performance on the Wada memory test, which might have led to lack of association between hemispheric seizure onset location and memory performance. On the other hand, RTLE individuals exclusively showed memory dominance on their left hemisphere. Due to the limited sample size, it is unclear whether the unusual pattern of distribution (Loring et al., 2009) seen in the current study is reflective of true language dominance differences.

Results of the current study showed no differences in visual memory performance between Spanish-speaking people with right or left memory dominance, reflecting a similar pattern as that seen in English-speaking individuals (Hanoglu et al., 2013; Vingerhoets et al., 2006). Nevertheless, results regarding verbal memory lateralization suggest a different pattern than that found among English-speaking individuals (Hanoglu et al., 2013; Vingerhoets et al., 2006). Specifically, this study of Spanish speakers found that those with left memory dominance, as measured by WMAs, did not differ in their performance on verbal memory measures compared to those with right memory dominance.

The results of this study suggest that the material-specific memory model may not be as strongly marked as previously thought among individuals with TLE, which has also been seen in recent research in a pediatric epilepsy sample (Salinas et al., 2018). Furthermore, this study might also suggest that the material-specific memory model may not be as marked in Spanish-speaking adult patients with epilepsy, specifically. This trend could have implications on our reliance of these associations when conducting presurgical evaluations.

Furthermore, the current findings might be the result of more complex cognitive phenotypes within TLE than previously thought. As described by Hermann et al. (2021)

cognitive deficits might not be clearly delineated by type of focal epilepsy, therefore, individuals with TLE could fall into one of three categories: 1) minimally impaired, 2) memory impaired, and 3) memory, executive functioning, and processing speed impaired. This possible heterogeneity within epilepsy syndromes, which has been replicated in a Spanish-speaking sample (Reyes et al., 2023), might explain the lack of associations found in this study.

Overall, based on the results of seizure focus and lesion, these findings indicate that WMAs are useful markers of cognitive dysfunction lateralization among Spanish-speaking individuals with unilateral TLE (i.e., LTLE, RTLE), especially among those with known right hemispheric lesions and/or electrographic abnormalities. Moreover, this study also showed that the NeSBHIS memory measures (i.e., WHO-UCLA AVLT, ROCFT) are not as efficient in lateralizing to the left or right temporal lobe among Spanish-speaking individuals with TLE, especially when comparing it to the Wada test. Therefore, these results support the necessity for the ongoing use of the Wada test during presurgical evaluations of Spanish-speaking individuals with TLE.

Limitations and Future Directions

Study limitations include aspects of tests and interpretations, the sample, and the use of retrospective data. It is important to note that Wada protocols are not standardized measures and differ between centers. The generalizability of Wada scores is further complicated by differences of amobarbital dosage (Loring et al., 1992), the stimuli presented (Loring, Hermann et al., 1997), the timing of stimulus presentation (Loring, Meador et al., 1997), and the encoding approach (Vingerhoets et al., 2006). Furthermore, score interpretations including cut-off scores differ between sites (Alpherts et al., 2000; Lee et al., 2002; Sabsevitz et al., 2001). Therefore, caution should be used when making comparisons across studies that use Wada data. Nevertheless, albeit the limitations in universal standardization and lack of normative references, the Wada procedure is considered a “gold standard” for the presurgical workup of individuals with temporal lobe epilepsy (TLE; Loring et al., 2009) and has been widely used in research of this population.

The retrospective nature of the data used for this study limited further investigations on the trends seen in this study. For example, information on further information on antiseizure medications or on bilingualism status and information related to health literacy was not available for the majority of participants, which could have affected neuropsychological results (Eddy et al., 2011; Reyes et al., 2018). Cognitive deficits attributed to epilepsy also have been seen to differ depending on the etiology of seizures (i.e., lesional, not lesional), seizure frequency, and location of epileptogenic zone within the temporal lobe (Baxendale & Thompson, 2010). Moreover, the present sample had limited data on MRI findings and localization of lesions, which consisted of the presence of brain lesions on the right or left temporal lobe. This might have limited further conclusions on the data given that greater cognitive differences have been noted in individuals with greater number of abnormalities as seen through magnetic resonance volumetrics (Hermann et al., 2006), as well as those with hippocampal sclerosis, specifically (Phuong et al., 2021).

Another limitation of this study is the small sample size. Future studies on lateralization of verbal and visual memory among Spanish-speaking individuals with TLE while using the Wada test would benefit from using a larger sample size. Replicating the current study with a larger sample size would help clarify to what extent Spanish- and English-speaking individuals with TLE differ in terms of memory lateralization, and to what extent their presurgical evaluations should differ.

These limitations aside, this study was the first that we know of to investigate memory type lateralization among Spanish-speaking individuals with TLE using Wada memory scores. The results suggest some similarities and some differences in memory lateralization trends when compared to English-speaking individuals with TLE. Overall, the lack of association between memory type (i.e., verbal, visual) and hemispheric memory functioning suggests that assumptions on Spanish-speaking individuals with TLE should be made with caution, and that further research on this population is imperative to ensure safe and effective presurgical evaluations and our understanding of material-specific memory model among Spanish-speakers. Future studies on this topic should bare in mind that epilepsy-specific (seizure age of onset, duration, frequency) and other (demographic, linguistic status, health literacy, health education/awareness) variables might be important covariates when looking at lateralization of memory performance.

Although reports on the prevalence of epilepsy among Hispanic individuals in the United States is limited, some sources suggest that epilepsy incidence could be up to twofold among Hispanic individuals when compared to non-Hispanic individuals (Centers for Disease Control and Prevention [CDC], 2003). This trend has been linked to increased rates of neurological conditions associated with epilepsy onset, such as birth trauma, stroke, head trauma, and cysticercosis (Grisolía et al., 2000). Moreover, Hispanic individuals with epilepsy are less likely to access surgical treatment for their condition compared to white individuals (Schiltz et al., 2013), possibly due to a combination of reasons including communication barriers, education, social support, physician bias, and lack of access (Nathan & Gutierrez, 2018). Given the higher prevalence of epilepsy and increased barriers to treatment, it is essential to continue researching epilepsy among Hispanic individuals, with the hopes of a better understanding of seizure disorders and the goal of elevating quality of life in these underserved patients.

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