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Naming decline after epilepsy surgery is associated with subjective language complaints☆

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ABSTRACT

Objective: This retrospective, observational study investigated the relationship between objective naming decline and patient report of subjective decline in language functioning following epilepsy surgery. The role of depression in this relationship was also examined.
Methods: A total of 429 adults with pharmacoresistant epilepsy completed the Boston Naming Test (BNT) and Memory Assessment Clinics Self-Rating Scale (MAC-S) before and after resective surgery. Multiple regression analyses were used to examine the relationship between objective naming decline and subjective language functioning, while controlling for the confounding effect of depression.
Results: Individuals who experienced moderate to severe naming decline (≥11 raw points on BNT) following surgery reported a decline in subjective language functioning ($p < .001$) and endorsed problems with word-retrieval as well as more general semantic abilities. Those who experienced mild naming decline (5–10 raw points) also reported an increase in subjective language problems ($p = .006$). Complaints in this group were less severe than in those with more marked naming declines and were primarily related to word-retrieval. Both of these relationships remained significant after controlling for the confounding effect of depression ($p < .005$–$.014$).
Conclusions: Individuals with epilepsy who experience naming decline following surgery perceive these declines in their daily life, regardless of whether or not they are depressed. Findings support the utilization of risk models to predict naming outcome and the importance of counseling patients regarding the risk for naming decline following surgery.

1. Introduction

Up to 60% of individuals who undergo surgical treatment for epilepsy experience postoperative language decline [1–3], and word-finding difficulties are the most common complaint among people with epilepsy [4,5]. Given the high prevalence of naming decline following surgery and evidence that some patients experience marked decline reflective of a broader aphasic syndrome [3], many studies have focused on identifying risk factors for naming decline following epilepsy surgery [3,6–14]. However, little is known about the impact of postoperative naming decline on patient experience. Although objective changes on neuropsychological tests can provide important information regarding cognitive outcomes following surgery, the extent to which patients perceive and are affected by cognitive changes as a result of surgery is also important to consider, particularly given that subjective complaints are associated with poorer quality of life [15] and may influence surgical outcome satisfaction.

To date, there has been extensive research into the relationship between subjective and objective memory in epilepsy, and a majority of studies reveal a stronger association between subjective memory complaints and mood than between subjective and objective memory functioning [16]. Research also suggests that memory complaints in individuals with temporal lobe epilepsy are more highly correlated with scores on verbal fluency [17,18] and naming [8] tests than performance on episodic memory measures.

Considering the risk of naming decline following surgical intervention and the lack of studies that have specifically examined objective and subjective language functioning following surgery, the objectives of the current study were to (1) examine the relationship between objective naming decline and subjective decline in language functioning, and (2) determine the role of depression in the relationship between objective and subjective language decline.

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2. Methods

2.1. Standard protocol approvals, registrations, and patient consents

Data for this retrospective study were obtained from an Institutional Review Board-approved data registry containing demographic, cognitive, seizure-related, and surgical variables for patients who underwent epilepsy surgery for the treatment of pharmacoresistant epilepsy. Approval to conduct this study was received from the Cleveland Clinic Institutional Review Board.

2.2. Participants

All patients underwent surgical resection between 1991 and 2018. Patients were selected for the study if they met the following inclusion criteria: 1) ≥17 years of age; 2) completed both pre- and postoperative neuropsychological evaluations that included the 60-item Boston Naming Test (BNT) [19] and the Memory Assessment Clinics Self-Rating Scale (MAC-S) [20]; and 3) had no history of prior neurosurgery.

2.3. Measures

2.3.1. Naming

Naming outcome was assessed using the BNT [19], an established and widely used measure of visual confrontation naming that consists of 60 line drawings. Patients were asked to provide the name for the object in the drawing. If they were unable to generate the name, they were provided with a stimulus cue (e.g., a piece of furniture) and/or phonemic cue (e.g., it begins with the sound bĕ-). Items that were correctly named spontaneously or with a stimulus cue were awarded one point for a total of 60 possible points. All patients completed the measure both prior to and following epilepsy surgery as part of standard clinical neuropsychological evaluations. Change scores were calculated by subtracting preoperative raw scores from postoperative raw scores, and participants were categorized into one of three groups based on magnitude of postoperative naming decline as done in our prior work [3,6]. Specifically, change scores were categorized as follows: no decline (<5 raw points), mild decline (5–10 points), and moderate/severe decline (≥11 points).

2.3.2. Subjective language function

Subjective language functioning was assessed using the MAC-S [20], a measure that utilizes a 5-point Likert scale to rate the severity of subjective cognitive complaints along a continuum. The measure consists of 45 items that are divided into two summary scales (Ability and Frequency) and 4 stand-alone global items [20]. The Ability scale consists of 21 items that assess perceived cognitive functioning in general as well as in comparison to others. Items on the Ability scale are grouped into five subscales (Remote, Numeric, Everyday, Semantic, and Spatial). The Frequency scale consists of 24 items that assess the frequency of cognitive concerns, also grouped into five subscales (Semantic, Concentration, Everyday, Forgetfulness, Facial). Although the MAC-S was designed to assess subjective memory functioning, it includes items that are characteristic of other cognitive abilities (e.g., attention, language). Thus, we selected subscales from the MAC-S believed to be most relevant to language functioning (i.e., Semantic Ability and Semantic Frequency subscales).

Patient ratings for each of the items on these subscales were summed, and then raw scores were transformed into standard scores (M = 100, SD = 15) using available normative data [21]. Higher standard scores represent fewer or less frequent cognitive complaints, and lower standard scores represent greater or more frequent cognitive complaints. To assess postoperative change in subjective ratings, change scores were calculated for both of the MAC-S Semantic subscales. To assess item endorsement, patient ratings for each item on the Semantic subscales were classified into two groups based on the severity of their complaints. On the Semantic Ability subscale, ratings were classified as poor functioning (endorsed 'poor' or 'very poor' language abilities) or normal functioning (endorsed 'about average,' 'good,' or 'very good' language abilities). On the Semantic Frequency subscale, ratings were classified as frequent problems (endorsed language difficulty 'often' or 'very often') or infrequent problems (endorsed language difficulty 'occasionally,' 'rarely,' or 'very rarely').

2.3.3. Depression

The Beck Depression Inventory (BDI), first or second edition [22,23], was used to assess depressive symptoms following surgery. Scores range from 0 to 63 with higher scores reflecting greater depressive symptoms. A cutoff score of 14 was used to classify patients as depressed (≥14) or not depressed (<14) following surgery [23].

2.4. Statistical analysis

Descriptive statistics were calculated to describe sample characteristics, and a series of analysis of variance (ANOVA) and chi-square analyses was used to identify any preexisting differences between the study groups. Demographic factors and depressive symptoms were considered as potential confounding variables. Bivariate correlations were used to identify confounds; any variable found to be significantly associated with both naming decline and perceived language functioning was included as a covariate in final linear regression models. Multiple regression analyses were used to model the relationship between objective naming declines and patient perception of language functioning, while controlling for confounds as necessary. Finally, chi-square analyses were used to assess differences in item endorsement on the MAC-S Semantic subscales between the three naming outcome groups. Tests were two-tailed and statistical significance was set at $p < .05$. Analyses were conducted with SPSS 25.0 (SPSS Inc., Chicago, IL).

3. Results

3.1. Sample characteristics

A total of 1474 patients underwent surgical resections and neuropsychological testing between the years 1991 and 2018. Of those, 429 patients met all inclusion criteria. On average, patients were 36 years old (range 17–73 years) and had 13 years of education (range 7–21 years). At seizure onset, patients were an average of 17 years old (range <1–62), and mean duration of epilepsy (age at assessment minus age at onset) was 19 years (range 1–60). Fifty-four percent of patients were female, and 95% characterized themselves as white. Patients completed postoperative neuropsychological testing a median of 6 months (IQR = 5.7–7.1) following surgery and 10 months (IQR = 8.3–14.0) following their preoperative assessment.

Preoperative BNT performance did not significantly differ between naming outcome groups. Twenty-five percent of the sample experienced postoperative naming decline. Patients who experienced moderate/severe naming declines following surgery were older than those who experienced either a mild decline or no decline. There was also a significant difference between naming outcome groups in age at seizure onset, with older onset age associated with greater postoperative naming decline. There was a disproportionate percentage of patients with left temporal resections in the two decline groups relative to the no decline group. Patients with moderate/severe naming declines following surgery reported greater depressive symptoms both pre- and postoperatively. Demographics and disease characteristics of each group are summarized in Table 1.

3.2. Confounds

Postoperative depression was found to be positively correlated with both BNT change ($r = 0.281$, $p < .001$) and MAC-S change on both the Semantic Ability ($r = 0.229$, $p < .001$) and Semantic Frequency subscales

Table 1
Characteristics and comparison of naming decline groups.

	No decline n = 321	Mild decline n = 63	Moderate/severe decline n = 45		
	M (SD)	M (SD)	M (SD)	*F*	*p*
Age	34.9 (10.4)	36.2 (9.5)	44.4 (13.1)	15.85	<**.001**
Education	13.2 (2.4)	13.0 (1.8)	13.3 (2.2)	0.27	.765
Age of seizure onset	15.3 (11.6)	19.7 (12.6)	25.3 (15.2)	15.44	<**.001**
Duration of epilepsy	19.6 (11.7)	16.6 (10.3)	19.0 (16.0)	1.69	.186
BNT pre-op	47.5 (8.3)	46.6 (7.0)	48.1 (7.9)	0.56	.570
BNT post-op	48.65 (7.9)	39.30 (7.3)	29.7 (9.3)	133.81	<**.001**
BDI pre-op[a]	10.5 (9.0)	13.1 (8.9)	16.0 (11.0)	8.0	<**.001**
BDI post-op[b]	7.59 (8.48)	9.81 (9.0)	16.32 (12.0)	18.74	<**.001**
	Number (%)	Number (%)	Number (%)	χ^2	*p*
Sex (female)	166 (51.7)	38 (60.3)	29 (64.4)	3.65	.161
Race (white)	307 (95.6)	59 (93.7)	41 (91.1)	6.92	.328
Handedness (right)	275 (85.7)	57 (90.5)	39 (86.6)	4.51	.342
Pathology (MTS)	160 (49.8)	34 (54.0)	21 (46.7)	14.40	.155
Resection side (dominant)[c]	124 (39.5)	51 (81.0)	40 (93.0)	77.76	<**.001**
Left hemisphere resection	140 (43.6)	57 (90.5)	43 (95.6)	78.93	<**.001**
Left Temporal	115 (35.8)	53 (84.1)	41 (91.1)	7.41	**.025**
Left Extratemporal	25 (7.8)	4 (6.4)	2 (4.4)		
Right hemisphere resection	181 (56.4)	6 (9.5)	2 (4.4)	78.93	<**.001**
Right Temporal	150 (46.7)	6 (9.5)	0 (0)	10.74	**.005**
Right Extratemporal	31 (10.3)	0 (0)	2 (4.4)		
Seizure-free at postoperative assessment	246 (76.6)	48 (76.2)	38 (84.4)	1.72	.787

M = mean; SD = standard deviation; BNT = Boston Naming Test; BDI = Beck Depression Inventory; pre-op = preoperatively; post-op = postoperatively; MTS = mesial temporal sclerosis.
[a] Pre-op BDI scores were not available for 3 patients in the No Decline group.
[b] Post-op BDI scores were not available for 1 patient in the No Decline group and 1 patient in the Moderate/Severe Decline group.
[c] Language dominance was not available for 7 patients in the No Decline group and 2 patients in the Moderate/Severe Decline group. Right-handed individuals without a language lateralization procedure were coded as having left-sided language dominance.

($r = 0.213$, $p < .001$). Therefore, postoperative depression was included as a covariate in all analyses.

3.3. Semantic ability subscale

Patients who experienced a moderate/severe postoperative naming decline decreased 8.7 standard points more on the MAC-S Semantic Ability subscale (i.e., increased language complaints) than those who did not decline on the BNT ($\beta = 8.714$, $p < .001$). This relationship remained even after controlling for the confounding effect of depression; those who experienced a moderate/severe decline on BNT decreased 6.5 standard points more than those who did not decline on the BNT ($\beta = 6.524$, $p = .001$). See Fig. 1.

3.4. Sematic frequency subscale

Those who experienced a mild naming decline decreased 6 standard points more on the MAC-S Semantic Frequency subscale (i.e., increased language complaints) than those who did not decline on the BNT ($\beta = 6.139$, $p = .006$), and those who experienced a moderate/severe decline decreased 10 standard points more than those without naming declines ($\beta = 10.040$, $p < .001$). Again, these relationships remained significant even after controlling for depression. Those who experienced a mild naming decline decreased 5.4 standard points more than those who did not decline on the BNT ($\beta = 5.438$, $p = .014$), and those who experienced a moderate/severe naming decline decreased 7.5 standard points more than those who did not decline on the BNT ($\beta = 7.489$, $p = .005$). See Fig. 2.

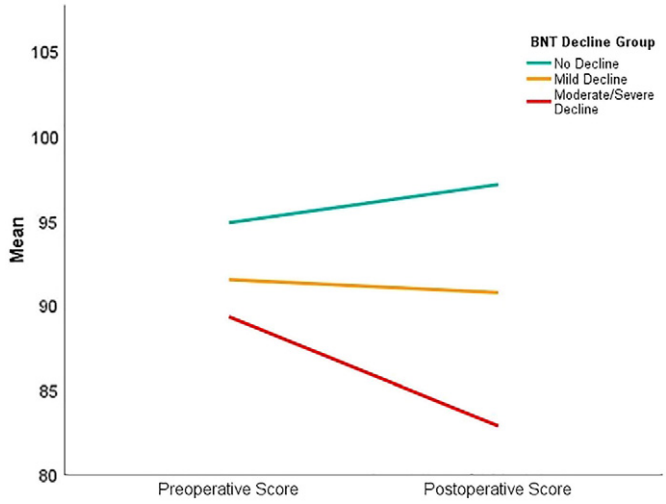

Fig. 1. Changes in scores on the Semantic Ability subscale as a function of naming outcome.

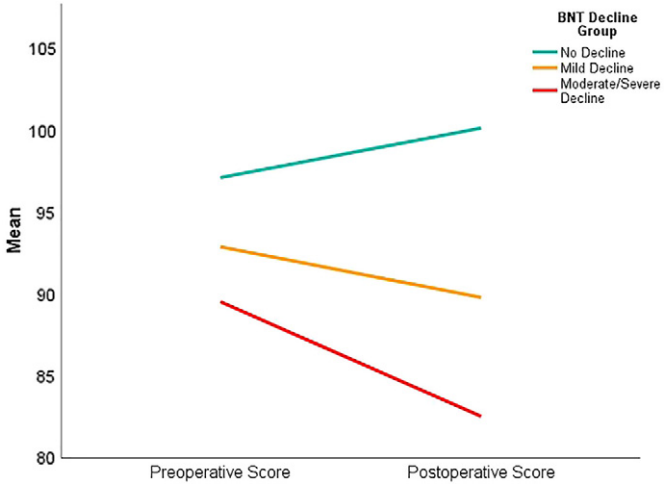

Fig. 2. Changes in scores on the Semantic Frequency subscale as a function of naming outcome.

Table 2
Postoperative item analysis: patients that reported frequent ('often' or 'very often') language complaints on the Semantic Frequency subscale and poor ('poor' or 'very poor') language abilities on the Semantic Ability subscale.

	No decline	Mild decline	Moderate/Severe decline		
	Number (%)	Number (%)	Number (%)	χ^2	*p*
Semantic Frequency subscale					
#26 Difficulty recalling a word you wish to use	121 (37.7)	36 (57.1)	35 (77.8)	30.2	<**.001**
#30 Word or name you want to remember is 'on the tip of your tongue' but cannot be recalled	134 (41.7)	44 (69.8)	38 (84.4)	40.0	<**.001**
#31 Forget the name of a familiar object	57 (17.8)	29 (46.0)	33 (73.3)	73.1	<**.001**
#33 Fail to remember a name or word when trying, but recall it later	97 (30.2)	33 (52.4)	30 (66.7)	29.6	<**.001**
#36 Take a surprisingly long time to recall a fact that you know quite well, and do eventually remember	51 (15.9)	20 (31.7)	23 (51.1)	32.7	<**.001**
Semantic Ability subscale					
#3 Specific facts from a newspaper or magazine article you have just finished reading	76 (23.7)	23 (36.5)	25 (55.6)	21.5	<**.001**
#12 Meanings of words that you use only rarely	110 (34.3)	33 (52.4)	28 (62.2)	17.6	<**.001**
#18 Meanings of words you once knew very well	51 (15.9)	13 (20.6)	23 (51.1)	30.2	<**.001**

3.5. Item endorsement

Item endorsement on the MAC-S subscales differed among the groups, with a greater proportion of decliners rating their language abilities as "poor/very poor" and the frequency of language problems as "often/very often" compared to those who did not experience postoperative naming declines (Table 2). The most frequently endorsed items by those who declined on the BNT were related to word-retrieval difficulties. Specifically, 67–84% of the moderate/severe decliners and 52–70% of the mild decliners endorsed frequent word-finding difficulties on the Semantic Frequency subscale. A majority of moderate/severe decliners also endorsed difficulty with more general language abilities (e.g., 'Meanings of words that you use only rarely').

4. Discussion

This study investigated the relationship between objective naming decline and subjective complaints in language functioning in individuals who underwent surgical treatment for epilepsy. Although objective naming decline is a known risk of epilepsy surgery, the impact that postoperative naming decline has on patients has not been well-studied. Results of this study demonstrate that individuals who experience moderate to severe naming declines following surgery report a subjective decline in language functioning. Interestingly, examination of item endorsement on the MAC-S Semantic subscales revealed primary difficulties with word-retrieval (e.g., "Feel that a word or name you want to remember is 'on the tip of your tongue' but cannot be recalled") as well as more general semantic abilities (e.g., "Meanings of words you once knew very well"). While those who experience mild naming decline also report an increase in subjective language problems, they do not complain to the same extent as those with more severe declines, and complaints in this patient subgroup are generally restricted to word-retrieval difficulties. Notably, word-finding difficulty was the most common language problem endorsed by individuals who experienced clinically meaningful postoperative naming declines, with 67–84% of moderate to severe decliners and 52–70% of mild decliners endorsing frequent (i.e., often or very often) word-retrieval problems in their daily life. Taken together, these findings are consistent with literature citing word-finding difficulty as the most common cognitive complaint among individuals with epilepsy and provide evidence that these complaints often reflect actual naming problems.

Existing literature indicates that depression plays a large role in subjective memory complaints both in epilepsy [16] and other populations [24–27] and that the relationship between subjective memory complaints and depression is much stronger than the relationship between subjective memory complaints and objective memory performance. Interestingly, our results suggest that depression plays much less of a role in subjective report of language functioning. The relationship between objective declines in naming and subjective report of language functioning remained even after controlling for depressive symptoms. These findings suggest that there may be something more tangible about language functioning that allows for more accurate appraisal of these abilities relative to other cognitive functions. Indeed, individuals have difficulty accurately evaluating their memory and often refer to language functions when describing memory complaints (e.g., "I cannot remember the word I want to use") [17]. This is further supported by the documented associations between language abilities (i.e., verbal fluency and naming) and subjective memory complaints [17,18].

A majority of the patients who experienced naming decline following surgery underwent left temporal resections. They were also older in age at both seizure onset and time of surgery compared to those that did not experience naming decline. Taken together, these findings are consistent with existing literature indicating that side of surgery [3,6–8], age at seizure onset [3,6,9,11,12,28,29], and age at surgery [3,6,7] are important variables in predicting postoperative naming decline. Individuals that experienced naming decline also endorsed greater depressive symptoms both at baseline and following surgery, and those with moderate/severe naming declines had the greatest number of depressive symptoms at both time points. These findings are in line with research demonstrating greater postsurgical memory declines in individuals with depression who underwent left temporal lobe resections [30]. The more severe naming decline observed in our patients with depression may be related to limited functional reserve capacity, as prior research has demonstrated more widespread neuroimaging abnormalities in patients with epilepsy and comorbid depression compared to nondepressed patients and healthy controls. [31–37]. In other words, patients with epilepsy and depression may have more significant and widespread functional brain abnormalities that limit their ability to compensate for focal damage imposed by epilepsy surgery. Further investigation is needed to confirm this hypothesis.

This study must be viewed in light of several limitations. As mentioned in the methodology, the MAC-S was designed to evaluate subjective memory and, although it includes a number of language-related items, language functioning constitutes a relatively small component of the measure. Further, although the BNT is widely used to evaluate objective naming ability, the Auditory Naming Test (ANT) [38] has been found to more closely approximate perceived word-finding difficulties in everyday life [38]. Thus, the relationship between objective and subjective naming ability may be even stronger if assessed in relation to performance on the ANT. Unfortunately, the ANT was added to our clinical epilepsy battery much later than the BNT, and the small proportion of patients who received the ANT in our sample precluded examination of this relationship. Finally, postoperative decline in other cognitive domains, such as executive functioning, may also impact patient perception of daily functioning and quality of life. Despite this, there is little research on the relationship between objective and subjective executive functioning following epilepsy surgery. Research that

extends the current literature by investigating this relationship will be important to better characterize surgical outcomes in the population with epilepsy.

5. Conclusions

In summary, the present study suggests that individuals who experience naming decline following epilepsy surgery perceive these declines in their daily life, regardless of whether they experience symptoms of depression. Considering the high prevalence of naming decline following epilepsy surgery and the negative impact that perceived naming decline likely has on quality of life, our results support the utilization of risk models [6] to predict naming outcome and the importance of counseling patients regarding the risk for naming decline following surgery. Future research examining the functional impact of naming decline (e.g., changes in job status, activities of daily living) will be important to better understand the impact of naming decline and inform surgery outcomes. In addition, rehabilitation interventions targeted at helping patients compensate for naming difficulties should be explored, as well as the possible influence that implementation of compensatory strategies may have on subjective cognitive complaints.

Declaration of competing interest

None.

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