

Memory for famous faces and the temporal pole: Functional imaging findings in temporal lobe epilepsy

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Abstract

The ability to recognize, name, and provide information about famous persons is deficient in patients with temporal lobe epilepsy (TLE), although the neural basis for these deficits is not well understood. We examined the relationship of resting metabolism of the temporal poles, as determined by [18F] fluorodeoxyglucose positron emission tomography, to performance on a task of famous face recognition, naming, and generation of semantic information in 12 patients with TLE. Correlations between metabolic measures of the temporal poles and performance on the Famous Faces Task revealed strong relationships between all aspects of the Famous Faces Task and the left temporal pole, whereas Famous Faces Task correlations with the right temporal pole were not significant. These findings indicate that the left temporal pole is associated with lexical and semantic retrieval of knowledge of famous persons in patients with TLE. Further study appears warranted to elucidate the networks involved in semantic knowledge for famous faces.

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1. Introduction

Understanding the brain mechanisms that underlie storage and retrieval of information about familiar persons is an area of interest from both cognitive neuroscience and neuropsychological perspectives. Recent models of semantic memory processes based on studies of individuals with localized lesions have shed light on associated neural networks involved in specific mechanisms of semantic memory retrieval. For instance, Markowitsch [1] has suggested a critical role for the temporal pole region in semantic memory retrieval. Fukatsu et al. [2] found that dominant left

anterior temporal lobectomy for the relief of intractable epilepsy resulted in postsurgical anomia specific to proper names, but spared the ability to provide semantic information regarding the individuals that could not be named. Grabowski et al. [3] observed that positron emission tomography (PET) activation of the left temporal pole was associated with proper name retrieval and also retrieval of names of famous landmarks among healthy normal subjects. These findings suggest that the left temporal pole is not exclusively tied to producing names of known faces per se, but is more accurately associated with the naming of unique entities.

Evidence also exists implicating the right temporal polar region in the processing of known faces. Tranel et al. [4] reported that an inability to retrieve semantic information about a known individual was associated with damage to

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the right temporal pole. Similarly, Papagno and Capitani [5] observed that more severe atrophy to the left rostral temporal regions accompanied proper name anomia with sparing of retrieval of semantic information about known individuals. However, when rostral temporal lobe atrophy was observed bilaterally, retrieval of both proper names and semantic information about known individuals was impaired [6]. Using a famous face paradigm, Glosser et al. [7] examined knowledge and naming deficits in both patients with right TLE and those with left TLE after anterior temporal lobectomy (ATL). Patients who underwent left ATL had the greatest impairment in the naming of famous faces, whereas patients who underwent right ATL had significant impairment in the retrieval of semantic information about the famous face. Such findings may lead to speculation of separate and distinct roles for the anterior temporal regions in each hemisphere.

It is, however, also possible that the successful retrieval of the names of known individuals by the left temporal pole may be dependent on the prior successful retrieval of semantic information by the right temporal pole. Grabowski and colleagues [8] demonstrated that with respect to functionality, both temporal polar regions may be interdependent, and that damage to the left temporal polar region may disrupt the facial recognition process as a whole. In their study of patients who underwent left ATL, these authors noted that regions normally engaged in the processing of known individuals in healthy control participants, including the right temporal pole, were less active in patients who had undergone left temporal pole excision as part of ATL.

Prior studies observing interrelationships between the left and right temporal poles and famous face processing provide evidence in support of a cognitive model proposed by Bruce and Young [9]. These authors posited that processing of known faces is sequential, distinct, and hierarchical, initially starting with perceptual face processing, and proceeding to facial recognition, retrieval of semantic information, and lexical (name) retrieval of a familiar person. Furthermore, successful completion of each cognitive step is dependent on input from the prior step. For instance, identification of a known individual begins with perceptual recognition, which in turn allows for access to semantic information about that individual. Only when semantic information has been accessed successfully can lexical retrieval be accomplished. Prior neuroanatomical observations interpreted within the context of this model would suggest that the left temporal pole is specialized for name retrieval, while the right temporal pole plays a more general role in identification and retrieval of knowledge about a famous face, and that both regions should be functional to successfully recognize, name, and provide accurate semantic information about a familiar person.

A prior behavioral investigation of patients with unilateral temporal lobe epilepsy (TLE) has yielded support for a stepwise, sequential model of facial processing similar to the Bruce and Young [9] model. Seidenberg and colleagues

[10] found that patients with unilateral TLE demonstrated specific impairments on a task of famous face recognition, naming, and semantic identification dependent on side of seizure focus. The specific deficits in patients with unilateral TLE were proposed to represent independent aspects of breakdown in a semantic network: patients with right TLE were impaired in recognition, semantic identification, and naming of famous faces, whereas patients with left TLE were impaired only in naming of faces, but were able to provide accurate and specific semantic information regarding the famous face. However, the relationship between famous face performance of patients with TLE and the right and left temporal polar regions remains unclear.

The purpose of the present study was to further investigate the role of the temporal poles in the processing of famous faces in TLE. We specifically sought to better understand how errors in recognition, identification, and providing semantic knowledge of known persons in patients with TLE, using a Famous Faces Task designed to operationally measure cognitive components of the Bruce and Young model, are related to PET resting metabolism of the temporal poles. We also sought to investigate the relationship of hemispheric laterality of the temporal pole PET resting metabolism to performance on the Famous Faces Task.

2. Method

2.1. Participants

Participants with TLE were recruited from a larger study of the neurodevelopmental impact of epilepsy [11,12] conducted at the University of Wisconsin Hospital Department of Neurology (UW). Initial selection criteria for epilepsy patients included the following: (1) chronological age from 14 to 60, (2) complex partial seizures of definite or probable temporal lobe origin (see details below), (3) absence of MRI abnormalities other than atrophy on clinical reading, and (4) no other neurological disorder. A board-certified neurologist with special expertise in epileptology reviewed patients' medical records. This review, blinded to all quantitative imaging and cognitive data, included seizure semiology, previous EEGs, clinical neuroimaging reports, and all available medical records. Based on this review, each patient was classified as having seizures of definite, probable, or possible temporal lobe origin. Definite TLE was defined by continuous video/EEG monitoring of spontaneous seizures demonstrating temporal lobe seizure onset; probable TLE was determined by review of clinical semiology with features reported to reliably identify complex partial seizures of temporal lobe origin versus onset in other regions (e.g., frontal lobe) in conjunction with interictal EEGs, neuroimaging findings, and developmental and clinical history. Only patients meeting criteria for definite and probable TLE proceeded to recruitment for study participation, whereas patients with possible TLE were excluded.

From the larger group of participants in the TLE study, 14 persons were selected who had undergone resting [^{18}F]fluorodeoxyglucose (FDG) PET scans as part of a presurgical workup for possible epilepsy surgery. Two left-handed persons from this group were excluded from the current study: in one case there was Wada evidence of right hemisphere language dominance, and in the second case, the Wada test was not performed. A third left-handed participant was included on the basis of confirmed left hemisphere language dominance on Wada testing. Four right-handed participants also showed evidence of left hemisphere

language dominance on Wada testing. The remaining seven participants did not undergo Wada testing, but were right handed and thus presumed to be left hemisphere language dominant for speech. Thus, the study consisted of 12 patients with TLE.

Demographic characteristics of the participants with TLE are summarized in Table 1. The demographic characteristics of these participants closely resemble those of other participants in the overall study [11,12] and also closely match those of other patients with TLE who have been evaluated for epilepsy surgery at UW [13].

Table 1 also provides data regarding the seizure characteristics of the participants. This group of TLE participants had inadequately controlled seizures as defined by a seizure frequency of at least one per month while on antiepileptic medications. The majority of the participants were on a polytherapy antiepileptic drug regimen (mode = 2 medications). On average, these participants experienced the onset of epilepsy in the early teenage years and had had epilepsy for more than 20 years. Ten of the participants had undergone continuous video/EEG monitoring of seizures; of these, six were determined to have seizure onset confined to the right temporal lobe, and three to the left temporal lobe; one patient had bilateral temporal lobe onset. Of the two participants for whom there were no video/EEG monitoring data, one was determined to have bilateral temporal lobe onset and one had indefinite laterality of temporal lobe seizures. Six of the 12 participants eventually underwent ATL at UW, and in all cases the side of resection was concordant with EEG localization. Two of the patients who underwent ATL were considered seizure-free, two were not seizure-free, one was lost to follow-up because of a postoperative stroke, and the sixth patient did not have follow-up as a result of relocation to another center. No participant had MRI evidence of lesions other than mesial temporal sclerosis and/or nonspecific atrophy.

Thirty-five healthy control volunteers (19 male, 16 female) were used as a normative sample against which to compare the participants with TLE on all behavioral measures investigated in this study (healthy controls did not undergo PET scanning). These control participants were friends or spouses of TLE participants in the larger UW study. Controls were, on average, 35.11 years old (SD = 13.70) and had an average of 13.09 years of education (SD = 3.49). Controls did not significantly differ from the participants with epilepsy in age or years of education (all *P* values > 0.10).

All participants gave informed consent for participation as a part of this UW institutional review board-approved research protocol.

2.2. PET methods

All 12 participants completed FDG-PET scanning as part of a clinical presurgical workup for epilepsy surgery. Participants fasted for a minimum of 4 hours before the PET scan. They were administered 5 to

10 mCi of FDG intravenously while resting comfortably in a quiet and dimly lit room. Patients were monitored for clinical evidence of seizure activity during the FDG uptake period. Interictal FDG-PET scans were obtained approximately 30 to 40 minutes after radiopharmaceutical administration. Examinations were performed with a GE Advance PET scanner (resolution approximately 5 mm full width half-maximum), and a series of 35 transaxial images of the brain were acquired over 20 minutes (35 planes per bed position over an axial field of view of 15.2 cm). Images were acquired with reference to the orbitomeatal line.

2.3. MRI acquisition and processing

We performed volumetric MRI studies to obtain neuroanatomically accurate regions of interest (ROIs) from the temporal pole to quantify our PET data. MRI scans were obtained on a 1.5-T GE Signa MR scanner. Sequences acquired for each participant included: (1) T1-weighted, three-dimensional SPGR acquired with the parameters TE = 5, TR = 24, flip angle = 40, NEX = 2, FOV = 26, slice thickness = 1.5 mm, slice plane = coronal, matrix = 256 × 192; (2) proton density (PD), and (3) T2-weighted images acquired with the parameters TE = 36 ms (for PD) or 96 ms (for T2), TR = 3000 ms, NEX = 1, FOV = 26, slice thickness = 3.0 mm, slice plane = coronal, matrix = 256 × 192, echo train length = 8. MRI scans were processed using Brain Research: Analysis of Images, Networks, and Systems (BRAINS 2), a semiautomated software package designed for analysis of structural and functional neuroimaging data [14]. With this software, the T1-weighted images were spatially normalized so that the anterior–posterior axis of the brain was realigned parallel to the AC–PC line, and the interhemispheric fissure was aligned on the other two axes. Images from the three MR sequences were then co-registered using a local adaptation of an automated image registration software [15]. Following alignment of the image sets, the PD and T2 images were resampled into 1-mm cubic voxels (T1 images were acquired with 1-mm voxels). Next, an automated algorithm using each image modality classified each voxel into gray matter, white matter, cerebrospinal fluid, blood, or “other” [16]. This segmentation procedure results in volumetric tissue measurements that account for continuous voxel registration and, thus, corrects for inaccuracies associated with partial volume effects.

Following this initial processing, a procedure for generation of three-dimensional maps of the cortical surface of the cerebral hemispheres was performed for each participant. Manual traces were performed that (1) divided the cerebral hemispheres along the longitudinal fissure, and (2) separated the cerebellum and pons from the rest of the forebrain. These traces, along with the tissue-classified image, were the input for a polygonization process that mapped the parametric center of the cerebral cortex for each hemisphere [17]. The resulting three-dimensional surface allows for the reliable identification of gyri and sulci for the purpose of measurement of the temporal pole [18].

2.4. Region of interest

The temporal pole was traced manually based on guidelines established for the parcellation of the temporal lobes [18]. By this method, tracing starts in the coronal plane immediately anterior to the frontotemporal junction and continues anteriorly until the temporal cortex disappears (see Fig. 1).

2.5. PET measurements

MRI and PET scan images were co-registered using an adaptation of an automatic image registration software [15] (see Fig. 2). Following co-registration, PET images were imported into BRAINS 2 to facilitate measurement of PET voxel intensity in the temporal pole ROI. The mean voxel intensity was measured and converted to a standardized value based on the mean and SD of each individual participant’s whole-brain PET voxel intensity. The resulting value is a *z* score that represents the variance of voxel intensity within the region in reference to the whole brain’s voxel intensity. Voxels were resampled to 1 mm³.

Table 1
Demographics and seizure characteristics of participants with TLE

Demographics	
Gender, female/male	9/3
Handedness, left/right	1/11
Age	37.0 (14.1) [14–58] ^a
Years of education	12.9 (2.2) [9–17] ^a
Seizure characteristics	
Participants with video/EEG monitoring, left/right/bilateral	3/6/1
Participants without video EEG/monitoring	2
Initial precipitating incident, yes/no ^b	7/4
Antiepileptic drug regimen, monotherapy/polytherapy	3/9
Age at onset (years)	14.1 (7.9) [2–35] ^a
Duration of epilepsy (years)	23.0 (14.9) [6–55] ^a
Seizure frequency in preceding year, weekly or more frequent/monthly	6/6

^a Mean (SD) [range].

^b Total reflects missing data.

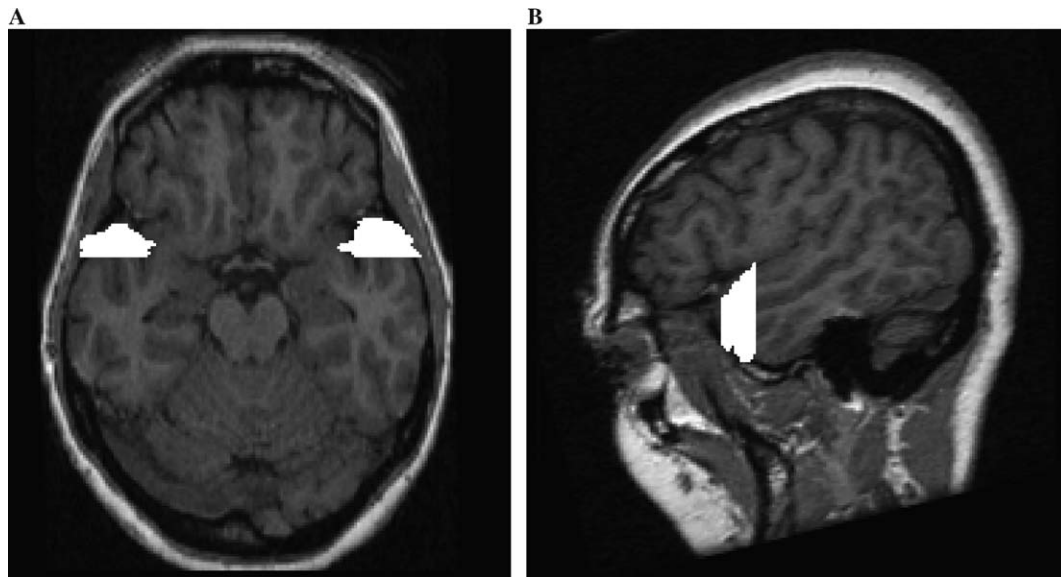


Fig. 1. T1-weighted MRI scans demonstrating the temporal pole regions of interest (highlighted). (A) Transaxial view; (B) parasagittal view.

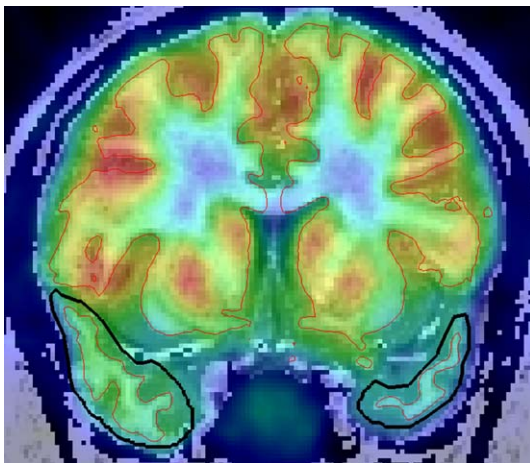


Fig. 2. Example of co-registered MRI–PET scan in coronal view demonstrating the temporal pole regions of interest (black outline).

For our participants with TLE, temporal pole PET measurements were conducted with an average of 91 pooled voxels within the left temporal pole and 78 voxels within the right temporal pole. Prior to correction for whole-brain voxel intensity, the mean and SD of voxel intensity in the left temporal pole were 97.64 and 13.01, and in the right temporal pole, 92.26 and 8.53, respectively. Following correction by each patient's whole-brain PET voxel intensity, the mean left temporal pole voxel intensity z score was -0.50 (range: -1.07 to -0.10), and the mean right temporal pole voxel intensity z score was -0.64 (range: -0.91 to -0.18).

2.6. Famous Faces Task

All participants were administered an adaptation of the Famous Faces Task previously investigated in patients with TLE [10]. In this paradigm, 20 famous faces are presented along with two foil faces, and participants are asked to identify the famous face (Recognition). If the face is not recognized, persons are cued to the correct famous face. Following correct recognition, participants are asked to name the famous person and provide as much information about that person as possible. If the participant cannot spontaneously name the famous face, a cue is given (first name) and subsequent semantic information is recorded following the cue. The information provided about the famous person is subsequently graded

for level of specificity (“specific” response, defined as spontaneously providing detailed information regarding the person and/or spontaneously providing general information about the person, such as the occupation). For the purposes of the current study, only spontaneously provided semantic information was analyzed (e.g., semantic information that was provided following the name cue was disregarded).

For the purposes of data analysis, four scores were derived from this task: Recognition, Naming, General Semantic (Occupation) Information, and Specific Semantic Information. Additionally, two scores were generated based on the proposed stages of famous face naming and semantic retrieval of the Bruce and Young [9] model. The Semantic Retrieval score was defined as the percentage of famous faces that were recognized (but not necessarily named) and for which specific semantic information was also provided. The Lexical Retrieval score was defined as the percentage of famous faces that were spontaneously named correctly (and thus, by default, recognized) and for which specific semantic information was also provided.

2.7. Measures of intelligence and perceptual face recognition

All participants were administered the WAIS-III [19] to characterize IQ scores. All participants were also administered a measure of perceptual face recognition, the Benton Facial Recognition Test [20], to characterize perceptual facial recognition of unfamiliar faces.

2.8. Statistical analysis

Correlations between performance on the Famous Faces Task (six scores) and temporal pole mean voxel intensity were computed using Pearson product–moment correlation. The influence of the number of antiepileptic drugs (AEDs) on temporal pole metabolism was measured using Pearson product–moment correlation. Partial correlation was used to investigate the impact of number of AEDs on the relationship between temporal pole metabolism and Famous Faces Task performance. An α level of 0.01 was adopted for all analyses.

3. Results

3.1. Famous Faces Task performance

Table 2 summarizes relevant comparisons of WAIS-III Full Scale IQ score, Benton Facial Recognition Test

Table 2
Comparison of performance on cognitive tasks and Famous Faces Task across study groups

Measure	Patients with TLE (<i>n</i> = 12)	Controls (<i>n</i> = 35)	Effect size ^a
Full Scale IQ			
Mean	95.9	110.6	1.03
SD	12.3	14.9	
Benton Facial Recognition (0–54)			
Mean	46.7	47.3	0.16
SD	3.3	3.9	
Famous Faces Recognized (0–20)			
Mean	17.0	17.6	0.23
SD	2.3	2.8	
Famous Faces Named (0–20)			
Mean	7.4	10.3	0.49
SD	4.9	6.2	
Famous Faces Semantic Occupation (0–20)			
Mean	13.7	15.9	0.50
SD	4.3	4.5	
Famous Faces Semantic Specific (0–20)			
Mean	9.8	13.3	0.61
SD	5.1	5.8	
Famous Faces Semantic Retrieval (0–100%)			
Mean	55.5	72.0	0.64
SD	24.7	25.9	
Famous Faces Lexical Retrieval (0–100%)			
Mean	68.0	72.8	0.20
SD	28.4	22.1	

^a Cohen's *d*.

performance, and Famous Faces Task performance between patients with TLE and controls. As expected, average IQ scores of the patients with TLE were lower than those of the control participants. However, there was no apparent difference between controls and participants with TLE on perceptual matching of faces as tested by the Benton Facial Recognition Test. Famous Faces Task performance was lower for all participants with epilepsy than for controls. Corresponding effect sizes for the group differences demonstrated minimal effect sizes for Lexical Retrieval (0.20) and Recognition (0.23) and moderate effect sizes for Naming (0.49), Semantic Occupation (0.50), Semantic Specific (0.61), and Semantic Retrieval (0.64) information.

3.2. Correlations between Famous Faces Task performance and PET

Left temporal pole mean PET intensity was strongly correlated with Recognition ($r = 0.74$, $P < 0.01$), Naming ($r = 0.78$, $P < 0.01$), Semantic Occupation ($r = 0.76$, $P < 0.01$), and Semantic Specific ($r = 0.82$, $P < 0.01$) information. None of the correlations between the right temporal pole mean PET intensity and Famous Faces Task performance measures approached significance. The asymmetry score derived by subtracting right from left mean PET intensity values of the temporal poles indicated moderately strong correlations with Recognition ($r = -0.58$, $P < 0.05$), Naming ($r = -0.64$, $P < 0.05$), Semantic Occupation ($r = -0.64$, $P < 0.05$)

Table 3
Observed correlations between PET metabolism and performance on Famous Faces Task

Measure	Left TP ^b	Right TP	TP asymmetry ^a
Recognition	0.74 ^c	0.34	-0.58 ^d
Naming	0.78 ^c	0.31	-0.64 ^d
Semantic Occupation	0.76 ^c	0.31	-0.64 ^d
Semantic Specific	0.82 ^c	0.37	-0.65 ^d
Semantic Retrieval	0.84 ^c	0.39	-0.66 ^d
Lexical Retrieval	0.65 ^d	0.42	-0.42

^a Positive correlation = right > left; negative correlation = left > right.

^b TP, temporal pole.

^c $P < 0.01$.

^d $P < 0.05$.

and Semantic Specific ($r = -0.65$, $P < 0.05$) information, although these correlations failed to reach significance at our α level.

3.3. Correlations of PET with Famous Faces Task retrieval measures

The Semantic Retrieval score measures the percentage of famous faces for which specific semantic information was provided following correct recognition. PET of the left temporal pole ($r = 0.84$, $P < 0.01$) demonstrated significant correlations with Semantic Retrieval (Table 3). PET of the right temporal pole was unrelated to the Semantic Retrieval score.

The Lexical Retrieval score measures the percentage of famous faces for which a correct name was provided in addition to correct specific semantic information. Left temporal pole PET intensity exhibited a trend toward a correlation with the lexical retrieval score ($r = 0.65$, $P < 0.05$). No significant correlations or trends were observed between the other PET measures and Lexical Retrieval.

3.4. Relationship between temporal pole metabolism and number of AEDs

Left temporal pole PET exhibited a marginal positive correlation with the number of AEDs used ($r = 0.53$, $P = 0.079$), but the correlation between right temporal pole PET and number of AEDs was not significant ($r = 0.19$, $P > 0.10$). Partial correlations controlling for the influence of number of AEDs on the relationship between left temporal pole PET and Famous Faces indices revealed essentially no differences from the zero-order Pearson correlations between left temporal pole PET and Famous Faces performance (partial r 's ranging from 0.72 to 0.61; all P values < 0.05).

4. Discussion

The aims of the current study were to investigate the role of the temporal pole in processing of famous faces and to correlate laterality of resting metabolism of the temporal

poles to famous face processing in patients with TLE. Our findings demonstrated strong relationships between left temporal pole mean PET intensity and recognition, naming, and providing semantic information about a famous face. In addition, scores representing semantic retrieval were also associated with resting metabolism in this region. In contrast, there were no significant relationships between right temporal pole activity and Famous Faces performance. Regarding laterality, the correlations between temporal pole PET asymmetry and measures of famous face processing suggested that lower left temporal pole activity, relative to right temporal pole activity, was generally associated with poorer performance on the Famous Faces Task. These findings do not appear to be affected by the number of AEDs taken for seizure control by these patients.

Recognition and access to semantic information about a famous face for patients with TLE appear more strongly related to resting FDG-PET metabolism of the left temporal pole, although modest involvement of the right temporal pole was also observed. Furthermore, the left temporal pole's role appears to be most strongly related to retrieval of specific semantic information about a known individual, as illustrated by the correlations of the left temporal pole with the Semantic Retrieval score. Producing specific information about a familiar individual is generally classified as semantic memory, as it involves factual information and world knowledge, whereas episodic memory is more context-specific and involves recollection of prior experiences [21]. Markowitsch [1] reviewed the literature regarding the associations between brain lesions and retrieval of old memories and concluded that the left temporal pole was critical for retrieval of retrograde memory. Similarly, Damasio and colleagues have indicated that the temporal pole and extrasyllabic structures are critical components of selective lexical retrieval for specific semantic categories [22]. Our findings concur with these prior accounts of access to semantic information and illustrate that in patients with TLE, dysfunction of the left temporal pole results in a disruption of access to a specific category of semantic information: that of unique identities.

Asymmetry scores of FDG-PET metabolism suggest that the left temporal pole, in contrast to the right temporal pole, is more highly involved with recognition and retrieval of semantic information about a known individual. This finding is in partial contrast with our earlier behavioral observations in patients with TLE that demonstrated right hemispheric involvement in multiple stages of Famous Faces Task performance [10]. However, this prior study was behavioral and thus did not provide specific neuroanatomical measures of temporal lobe involvement in Famous Faces Task performance. There is neuroimaging evidence suggesting that the contralateral temporal lobe exhibits metabolic abnormalities in unilateral TLE, and thus, it might be suspected that cognitive functions of the contralateral temporal lobe could be disrupted [23–26]. Another study in patients

with TLE illustrated the importance of the temporal pole by demonstrating changes in performance on a Famous Faces Task after ATL that results in excision of the left temporal pole [8]. This earlier study also found no relationship between a Famous Faces Task and the remaining right temporal pole, although another study [27] reported right temporal pole involvement in famous face recognition and semantic access. However, no prior studies have reported on patterns of neuroanatomical functioning in famous face performance of patients with TLE prior to temporal lobe surgery.

Prior literature on facial processing suggests a bilateral, hierarchical network is involved in the identification of known persons. In keeping with the concept of the ventral visual “what” pathway [28], studies measuring basic perceptual facial processing have found the right fusiform gyrus to be specifically active [29]. However, when stimuli included both familiar and unfamiliar faces, bilateral activation in the fusiform gyri was observed, with a significant decline in activity in these areas on presentation of familiar faces as compared with unfamiliar faces [30]. A subsequent study [31] found greater activity in the right hemisphere for unfamiliar faces, indicating that regions in the right hemisphere related to facial processing are also involved in the discrimination of familiar from unfamiliar faces. In contrast, familiar faces may initiate a retrieval of semantic information about that particular face that is preferentially mediated by the left hemisphere, whereas unfamiliar faces may not trigger such a process, but prolong right hemispheric activity.

In the context set forth by Bruce and Young [9], our data provide further understanding of the neuroanatomical pathway most likely associated with famous face semantic retrieval in TLE. Although recognition of famous faces appears to be associated with the left temporal pole, our interpretation is that this finding represents the involvement of the semantic network in the Famous Faces Task rather than perceptual recognition processes. Thus, access to facial recognition units may preferentially involve right hemispheric visual regions, and then, as more semantic information is retrieved, the dominant hemisphere temporal pole may become more active. Although the temporal pole is not the person identity node itself, as evidenced by residual famous face naming processes in persons following temporal pole excision [8], nonetheless coordination of retrieval mechanisms by the temporal pole appears highly important to the efficiency of the semantic memory network underlying information for unique identities. In this way, the temporal pole could be thought of as coordinating—or flexibly associating—among semantic information sources about a unique individual, much in the same way that the hippocampus is thought to create associational representations for new memories by coordinating across a widespread neural network [32].

It is important to note the limitations of the present study. In concert with our aim, only patients with TLE

were included in the study. Thus, our findings cannot generalize to the general population, but can elucidate the role of the temporal polar regions in famous face processing among those with TLE. Our participants were a mixed group with mostly right and left TLE. Such a mixed group may have contributed to discrepancies with prior behavioral findings based on larger groups of patients with unilateral TLE [10]. Not all patients in the study had Wada evidence of language dominance, so it cannot be assumed that all right-handed participants were left language dominant. It is unclear how this might affect the pattern of findings, and replication in a sample with verified language dominance is recommended. Furthermore, our data are correlative and retrospective. It would be desirable to replicate such findings using an active functional imaging paradigm in both patients with TLE and neurologically healthy adults.

In sum, results from the present study strongly suggest that the left temporal pole, in contrast to the right temporal pole, is more highly involved with retrieval of semantic information about a known individual in persons with TLE. Prior evidence suggests that the right temporal pole is likely involved in more basic aspects of facial processing, rather than lexical and semantic retrieval aspects for famous faces. The left temporal pole involvement in semantic retrieval appears to be homologous to the hippocampus' role in episodic memory of activating diverse brain regions to represent a memory association. Future investigations should incorporate both functional and behavioral data in patients with well-characterized and lateralized unilateral TLE, compare task-specific regional activation in functional MRI, PET, and magnetoencephalography activations, observe postsurgical changes in facial processing and semantic retrieval in epilepsy patients who have undergone ATL, and investigate possible differences in activations among processing of famous places or well-known objects versus famous faces to further elucidate the neural networks involved in the processing of semantic memory for unique identities. Future studies with neurologically healthy patients would also be important to contrast to the effects that epilepsy has on functional and metabolic brain patterns in relation to Famous Faces Task performance.

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