



# Emotion recognition and social cognition in temporal lobe epilepsy and the effect of epilepsy surgery



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## ARTICLE INFO

### Article history:

Received 22 February 2014

Revised 26 April 2014

Accepted 1 May 2014

Available online xxxx

### Keywords:

Temporal lobe epilepsy

Emotion recognition

Social cognition

Epilepsy surgery

Seizures

## ABSTRACT

The abilities to identify facial expression from another person's face and to attribute mental states to others refer to preserved function of the temporal lobes. In the present study, we set out to evaluate emotion recognition and social cognition in presurgical and postsurgical patients with unilateral refractory temporal lobe epilepsy (TLE). The aim of our study was to investigate the effects of TLE surgery and to identify the main risk factors for impairment in these functions.

We recruited 30 patients with TLE for longitudinal data analysis (14 with right-sided and 16 with left-sided TLE) and 74 patients for cross-sectional data analysis (37 with right-sided and 37 with left-sided TLE) plus 20 healthy controls. Besides standard neuropsychological assessment, we administered an analog of the Ekman and Friesen test and the Faux Pas Test to assess emotion recognition and social cognition, respectively.

Both emotion recognition and social cognition were impaired in the group of patients with TLE, irrespective of the focus side, compared with healthy controls. The performance in both tests was strongly dependent on the intelligence level. Beyond intelligence level, earlier age at epilepsy onset, longer disease duration, and history of early childhood brain injury predicted social cognition problems in patients with TLE. Epilepsy surgery within the temporal lobe seems to have neutral effect on patients' performances in both domains. However, there are a few individual patients who appear to be at risk of postoperative decline, even when seizure freedom is achieved following epilepsy surgery.

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## 1. Introduction

Human social behavior is a high-level cognitive feature based on complex interpersonal interactions. The most important abilities are emotion recognition from another person's face and empathy to others' mental states. These processes are tightly connected, as disruptions of emotional processing result in changes in judgment about others' mental states [1]. It has been suggested that the temporal lobes play a central role for both cognitive domains [2,3].

The function of emotion recognition from facial expression is known to depend mainly on mesial temporal structures, with an important role played by the amygdala. For example, normal development of the amygdala has been shown to be essential for adequate fear recognition

[4]. This idea was supported by a recent study on children with early-onset temporal lobe epilepsy (TLE), in which emotion recognition deficit was found to be present since infancy and adolescence [5]. The amygdala also appears to mediate the connection between the perceptual representation of faces expressing emotions and the conceptual knowledge of what these emotions mean [6]. Although this function has traditionally been associated with the nondominant temporal lobe [6,7], there is evidence from fMRI studies that the activation of both temporal lobes occurs during emotion recognition [8].

The neuronal network underlying advanced social cognition and judgment about mental states is more complex. Imaging studies have shown the involvement of a widespread network of prefrontal, temporoparietal, and mesolimbic brain structures [9]. Clinical studies reported impairment in social cognition in patients with bilateral amygdala damage [10], and the amygdala was also shown to be essential for the acquisition of theory of mind abilities in childhood [11]. Overall, the nondominant temporal lobe seems to play a pivotal role in social behavior [12].

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In our study, an experimental neuropsychological protocol including the Emotion Recognition Test (ERT) and Faux Pas Test (FPT) was used to evaluate emotion recognition and social cognition in a group of patients with unilateral, drug/treatment-refractory TLE.

Specifically, our study was set up with the following aims: 1) to investigate the influence of epilepsy surgery on emotion recognition and social cognition in patients with TLE in both cross-sectional and longitudinal studies and 2) to identify the main risk factors for the emotion recognition and social cognition impairments.

## 2. Methods

We recruited 74 left-speech dominant patients with TLE who were investigated before or after temporal lobe resection for refractory epilepsy. Preoperative assessments were performed at the Epilepsy Centre at the University Hospital Motol in Prague during the period 2007–2012 using a noninvasive protocol (neurological history/examination, routine EEG, long-term video-EEG monitoring, MRI, and bilateral carotid sodium amobarbital/methohexital testing or fMRI for language). Neuropsychological testing included assessment of handedness and Czech versions of Wechsler Adult Intelligence Scale—Third Edition (WAIS-III), Digit Span, Rey Auditory Verbal Learning Test, Rey–Osterrieth Complex Figure Test, Verbal and Design Fluency Test, Boston Naming Test, Beck Depression Inventory, and Eysenck Personality Questionnaire. Invasive video-EEG was performed in selected cases when deemed necessary. All the patients had a diagnosis of unilateral mesial TLE according to electroclinical features. Patients with atypical (bilateral or right hemisphere) speech dominance were excluded from the study. Patients were considered eligible both before ( $n = 46$ ) and after ( $n = 28$ ) epilepsy surgery for the cross-sectional data analysis; however, no patient was included twice. When both presurgical and postsurgical evaluations were available, the presurgical one was used. Postsurgical patients were tested at least twelve months after surgery. The extent of resection, planned or performed, did not extend beyond the temporal lobe and included at least part of mesial temporal lobe structures in all patients. Both presurgical and postsurgical longitudinal data for the same patient were available in 30 cases.

The patients' clinical and demographic variables were obtained by reviewing their medical records. The following variables were collected: sex (binary), age at assessment (years, continuous), history of early childhood brain injury (i.e., birth trauma, head trauma, meningitis or encephalitis, febrile seizures before the age of four, binary), age at epilepsy onset (years, continuous), epilepsy duration (years, continuous), FSIQ scores (continuous), and seizure frequency (number per month, continuous). The control group consisted of 20 healthy subjects — right-handed healthy volunteers without a history of neurological or psychiatric disorder. The study was approved by the institutional ethics committee, and all participants signed an informed consent prior to enrollment. Standardized neuropsychological assessment was performed in all patients and controls. Patients with markedly low full-scale IQ level (FSIQ less than 65 points on full-scale IQ) were excluded from the study to rule out widespread cognitive impairment. Patients who had seizures within 24 h before testing were not assessed and were rescheduled.

### 2.1. The experimental neuropsychological protocol

The ERT was inspired by the Ekman and Friesen series of facial expressions, consisting of 25 photographs of five facial expressions of emotion: happiness, fear, sadness, disgust, and anger. The facial expression for surprise was excluded because it has been shown that this expression is often mistaken for fear [13]. There were verbal descriptions for each emotion below the photograph (the sequence of descriptions was changeable to exclude learning phenomenon). Each participant was instructed to choose one description for the emotion shown by the facial expression on the photograph. The maximum

score was 25 points. Correct answers were not provided, and there was no time limit to accomplish the task.

The short version of the FPT was adapted from Schacher et al. [12]. It included three short stories, all involving clear social faux pas. All participants silently read the story and, to reduce memory demands, kept the text of the story in front of them while questions were being asked. After reading each story, participants were asked to decide whether any characters said anything they should not have said or anything awkward. Correct answers required that the participant could understand the faux pas correctly and could infer the mental state of another person. Answers were rated as incorrect when the participant thought that there was an intention to harm the person in the story. If the participant did not identify any faux pas, two control questions were asked to verify the ability to understand the text. The score from the control questions was not computed toward the final score. The maximum score for all the three stories was 18 points. Correct answers were not provided, and there was no time limit to accomplish the task.

### 2.2. Cross-sectional data

In cross-sectional data analysis, we compared the results of the following: 1) all patients ( $n = 74$ ) versus controls ( $n = 20$ ), 2) patients with left-sided TLE ( $n = 37$ ) versus controls and patients with right-sided TLE ( $n = 37$ ) versus controls, 3) patients with left-sided TLE ( $n = 37$ ) versus patients with right-sided TLE ( $n = 37$ ), and 4) presurgical patients ( $n = 46$ ) versus postsurgical patients ( $n = 28$ ).

### 2.3. Longitudinal data

In the longitudinal study, we (1) compared presurgical and postsurgical results of the group ( $n = 30$ ) and (2) identified individuals with significant change (improvement or decline) after surgery, i.e., postoperative change in score  $\geq 3$  points in comparison with presurgical value to find out their specific clinical or demographic features.

### 2.4. Statistical analysis

Comparisons of continuous or ordinal variables between groups were performed using the *t*-test (two-tailed) or, in the case of nonnormality of collected data, the nonparametric Mann–Whitney *U* test (two-tailed). The Fisher exact test was used to compare categorical data. Spearman's rank correlation coefficient was applied to assess for correlations between ordinal variables. Univariate logistic regression analysis was used to determine the odds ratio of clinical and demographic characteristics. Subsequently, multivariate logistic regression was performed using the forward stepwise method with *p*-values lower than 0.05 for variables to be left in the model. The Wilcoxon matched pairs test was used for assessment of longitudinal data. *p* values  $< 0.05$  were regarded as statistically significant.

## 3. Results

The patients' demographic and clinical variables are presented in Tables 1 and 2.

### 3.1. Cross-sectional data analysis

Statistical analyses revealed significant differences in recognition of emotion ( $p = .0001$ ) and faux pas ( $p = .007$ ) between patients and controls. These differences remained significant for both tests when patients with left-sided (ERT:  $p < .001$ ; FPT:  $p = .004$ ) or right-sided (ERT:  $p = .004$ ; FPT:  $p = .047$ ) TLE were compared with controls. Patients with left-sided TLE did not differ in ERT ( $p = .263$ ) or in FPT ( $p = .267$ ) when compared with patients with right-sided TLE. In the cross-sectional analysis, the impairment demonstrated by patients

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