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The affective value of faces in patients achieving long-term seizure freedom after temporal lobectomy

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ABSTRACT

We investigated different aspects of facial expression evaluation in a homogeneous cohort of 42 seizure-free patients with 5 or more years of follow-up after temporal lobectomy (TL), with the aim of further characterizing the impairment in emotion and social cognition among patients. A group of healthy subjects matched for sex, age, and education served as controls. Four tasks of facial expression evaluation were used: (*a*) facial expression recognition, (*b*) rating of the intensity of facial expression, and (*c*) rating of valence (pleasantness) and (*d*) rating of arousal induced by facial expressions. Patients had a worse performance in the recognition task for all negative emotions, while no differences in intensity ratings were found. They also reported lower arousal ratings than controls for faces showing fear, anger, disgust, and neutral expressions, as well as lower valence ratings for all facial expressions except those showing happiness. Longer epilepsy duration before TL was negatively associated with ratings of arousal and intensity and positively associated with valence ratings for fearful facial expressions. This study showed that patients who become seizure-free after TL present long-term deficits in several aspects of facial expression evaluation. Longitudinal, prospective studies are needed to evaluate if social cognition improves or declines after TL.

1. Introduction

The temporal lobe, and the amygdala in particular, plays a crucial role in processing the appropriate cognitive, autonomic, and behavioral responses to emotional relevant stimuli. In the past decade, the role and the importance of the anteromedial temporal lobe region in decoding emotions have been demonstrated by a number of lesion and functional imaging studies [1]. In the field of epilepsy, this knowledge has several clinical as well as speculative implications. Indeed, temporal lobe epilepsy (TLE) is frequently due to hippocampal sclerosis (HS) or mass lesions involving the medial temporal lobe region. Moreover, temporal lobectomy (TL) is the "standard" treatment for drug-resistant medial TLE [2]. Consequently, the investigation of emotional and social competence in patients with TLE has been the focus of several studies [3–6].

A consistent finding emerging out of more than a decade of research in this field is that patients with TLE frequently show deficits in emotion recognition (ER) (either before or after TL), not only for facial expressions but also for different emotional stimuli such as prosody and music [3,4,7–15]. An important open question concerns the consequences (if any) of anteromedial temporal resections on ER abilities in patients with an enduring temporal lobe epileptic focus. From this point of view, the best answers would be provided by a large prospective study with pre- and postsurgery evaluation of ER skills. To date, only one small case study longitudinally evaluated patients with TLE before and after surgery (4–6 months), concluding that no worsening of performance was observed post-TL [16]. Overall, no study has yet addressed the ER ability of post-TL patients seen in long-term follow-up. Since several factors can contribute to the interpretations of neuropsychological findings in TLE and in TL patients (i.e., etiology, side of focus/surgery, age at epilepsy onset, and postoperative seizure freedom) [17–19], we studied ER in a homogeneous cohort of TL patients with more than 5 years of follow-up and seizure freedom. We focused on the judgment about facial expressions, which are the most powerful channel of emotion communication. We investigated different aspects of facial expression evaluation as we required subjects to rate the intensity, valence, and arousal dimensions of faces as well as to recognize facial emotions. Several clinical variables prior to surgery were considered to account for post-TL emotion recognition performances.

Abbreviations: TLE, temporal lobe epilepsy; TL, temporal lobectomy; ER, emotion recognition.

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2. Methods

2.1. Participants

The study was performed on two samples that were matched for sex, age range, and education. The first sample included 39 healthy controls, while the second sample comprised 42 patients with TLE due to HS who underwent epilepsy surgery and were followed up for at least 5 years. Eligible patients fulfilled the following inclusion criteria: (*a*) histologically confirmed HS, (*b*) documented age at TLE onset, (*c*) no other history of neurosurgery, and (*d*) full remission of seizures (Engel class I) over a follow-up period of at least 5 years. All eligible patients were contacted by telephone and asked to participate in the study. Forty-two patients gave their written informed consent to take part in the study according to procedures approved by the local ethics committee. Their mean duration of follow-up was 8.5 years (SD: 2.5; range: 5–13).

2.2. Surgical procedure

All operations were carried out under general anesthesia by the same neurosurgeon. Most patients (N = 30) underwent extended temporal lobectomy (ETL), while a few (N = 12) underwent anteromedial temporal lobectomy (AMTL). Both ETL and AMTL included microsurgical resection of the amygdala and en bloc excision of the hippocampal formation and parahippocampal gyrus. Nondominant ETL included excision of 4–4.5 cm of the superior temporal gyrus and the middle temporal gyrus and excision of 5–6 cm of the inferior temporal gyrus, whereas dominant ETL included excision of 4–5 cm of the middle and inferior temporal gyrus, although the superior gyrus was left intact. In AMTL, the extent of the neocortical excision was 3 cm for all the first three temporal gyri while sparing the superior gyrus in the dominant hemisphere [20].

2.3. Assessment

Patients and controls underwent four tests designed to analyze different aspects of facial expression evaluation. Stimuli consisted of pictures of facial affect taken from the Ekman and Friesen series [21]. The same 25 affective stimuli were used in the four tasks, and the selected faces posed prototypical expressions of happiness, fear, sadness, disgust, and anger. Normative data (for the Pictures of Facial Affect series) report the following mean percentages of correct recognition for the selected items: happiness = 99.2%, sadness = 95.6%, fear = 88.4%, disgust = 95.6%, and anger = 94.4%.

2.3.1. Recognition of facial expressions

We used a previously published protocol requiring subjects to match a facial expression with the appropriate verbal label, choosing among the five basic emotions [3,4,12]. Five pictures (including nonfacial features; i.e., hairs) were used for each emotion, giving a total of 25 trials.

The testing procedure was as follows: pictures were presented, one by one, on a PC screen. The verbal labels for the five facial expressions (happiness, fear, disgust, anger, and sadness) were reported under each picture, and the subjects were asked to select the word that best described the emotion shown in each photograph. All subjects understood the labels, as assessed by their ability to appropriately describe scenarios pertaining to that emotional label. The participants were instructed to consider all five alternatives carefully before responding. There was no time limit, and the patients were given no feedback on their performances. All the subjects completed the test without difficulty in a single session that typically lasted from 10 to 20 min.

After the emotion-labeling task, the subjects were presented with the following tasks that required them to rate the intensity, the arousal, and the valence of facial expressions.

2.3.2. Rating of intensity of facial expressions

We asked subjects to rate each stimulus on a 5-point scale with respect to the emotion depicted. Subjects were asked to judge each face on a scale of 0–5 (0 = not at all; 5 = very much) for the corresponding verbal label: happy, sad, disgusted, angry, and afraid; stimuli were presented on a PC screen in random order (Supplementary Fig. a). We used a simplified version of previously published tests on emotion intensity ratings [7,22,23]. We analyzed the rating of each emotion with respect to the prototypical expression of that emotion: i.e., we asked the subjects to rate the intensity of fear for fearful facial expressions by asking "how much do you think the person in the picture is afraid?". There was no time limit. Care was taken to ensure that all subjects knew which label they were rating and used the scale correctly.

2.3.3. Rating of arousal and valence elicited by facial expressions

We asked subjects to rate stimuli on two distinct attributes of emotion: valence (pleasantness–unpleasantness) and arousal. Subjects rated each stimulus on a 9-point scale with respect to the emotion depicted. Our rating instrument consisted of a one-dimensional grid onto which the subject placed an "x" (adapted from Adolphs et al. [24]); this was a simplified version of a previously developed rating instrument called the "Affect Grid," which has demonstrated reliability and construct validity (Russell et al. [25]). Subjects were asked to rate in their own personal dimension the level of arousal and valence evoked by each stimulus. Subjects were told that for the valence scale, ratings greater than 5 corresponded to feelings that were more pleasant than neutral, and ratings less than 5 corresponded to feelings that were less pleasant than neutral. We asked the patient to judge how much he/she feels pleasant/unpleasant in relation to the expression of that particular face. Similarly, for the arousal scale, subjects were told that ratings greater than 5 corresponded to higher energy/arousal/wakefulness than one's average arousal state, and ratings lower than 5 corresponded to lower energy/arousal or greater sleepiness/relaxation than one's average arousal state. Subjects were told that any given level of arousal could be experienced with either a pleasant or an unpleasant emotion.

The testing procedure (Supplementary Figs. b, c) was as follows: subjects were shown the same stimuli used for the recognition task plus 5 stimuli with neutral expressions (for a total of 30 stimuli). Each stimulus face was presented in random order, one at a time, twice (once for the valence rating and once for the arousal rating). No time limit was imposed.

2.4. Statistical analysis

All analyses were performed with SPSS for Mac, version 20. All statistical tests were two-tailed, with alpha set at 0.05.

First, a descriptive analysis was performed to study the frequency distribution of all variables of interest. Then, analysis of variance was used to test for between-group differences in scores on facial expression evaluation. In the clinical group, Pearson correlation coefficient was used to test the relationship between scores on the different tasks and duration of epilepsy, whereas analysis of variance was used to examine the association between scores and side of resection, history of perinatal distress or febrile convulsions, early age at epilepsy onset (<6 years of age), and type of temporal resection. Finally, multiple linear regression was used to test the association between performance on the recognition task and early onset of epilepsy while adjusting for current age.

3. Results

The demographic and clinical characteristics of participants are summarized in Table 1, while the scores obtained by the two groups on facial expression judgments are reported in detail in Table 2.

Patients displayed a significantly worse performance in the recognition task, with a significantly higher number of total and emotion-