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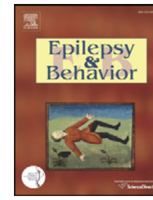

Recognition of emotions from faces and voices in medial temporal lobe epilepsy

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ABSTRACT

Patients with chronic medial temporal lobe epilepsy (MTLE) can be impaired in different tasks that evaluate emotional or social abilities. In particular, the recognition of facial emotions can be affected (Meletti S, Benuzzi F, Rubboli G, et al. Neurology 2003;60:426–31. Meletti S, Benuzzi F, Cantalupo G, Rubboli G, Tassinari CA, Nichelli P. Epilepsia 2009;50:1547–59). To better understand the nature of emotion recognition deficits in MTLE we investigated the decoding of basic emotions in the visual (facial expression) and auditory (emotional prosody) domains in 41 patients. Results showed deficits in the recognition of both facial and vocal expression of emotions, with a strong correlation between performances across the two tasks. No correlation between emotion recognition and measures of IQ, quality of life (QOLIE-31), and depression (Beck Depression Inventory) was significant, except for a weak correlation between prosody recognition and IQ. These data suggest that emotion recognition impairment in MTLE is not dependent on the sensory channel through which the emotional stimulus is transmitted. Moreover, these findings support the notion that emotional processing is at least partly independent of measures of cognitive intelligence.

1. Introduction

The recognition of emotional signals, from all sensory modalities, is a critical component of human social interactions because it is our understanding of the affective states of others that guides our behavioral responses [1]. Facial expressions provide the greatest amount of emotional cues useful to the recognition of "basic" emotions with both positive and negative value (fear, happiness, anger, sadness, disgust, surprise) [2,3]. On the other hand, emotional signals can be conveyed through different modalities, such as gestures, body posture, and the voice (emotional prosody) [4]. In the latter case we can understand the emotional state of the speaker through the modulation of the intonation of the voice.

In this study we were particularly interested in evaluating emotion recognition through the most frequently used channels of communication in human social interactions: facial expressions and emotional prosody. A network of cortical and subcortical structures participate in the process of recognition of emotions from facial expressions. Neuroimaging and lesional data support the involvement of the occipitotemporal neocortex, the amygdala, the orbitofrontal cortex, and the right frontoparietal cortices [5]. With respect to temporal lobe structures, there is general agreement that the amygdala is a key subcortical structure in facial expression processing. More debated is the role of the medial temporal lobe, and of the amygdala in particular, in the recognition of emotional prosody. Indeed, lesion studies addressing the role of the amygdala in the explicit recognition of emotional prosody have reported conflicting results [6–11]. However, it has been demonstrated in fMRI studies that the amygdala is involved in emotional processing regardless of the sensory modality through which stimuli are transmitted and especially when stimuli encode fear or danger [12,13].

Recently, the investigation of emotional and social competence in patients with TLE has been the focus of different studies [14–20], which have extended the scope of neuropsychological evaluation in TLE beyond the traditional assessment of cognitive functions [21–24]. These studies evaluated recognition of facial expressions, emotional memory, and advanced social cognition abilities (such as "theory of mind"), though they did not address the ability to process prosody, especially emotional prosody.

With regard to the recognition of facial emotions, anterior temporal lobectomy has been demonstrated to be associated with deficits in facial emotion recognition [25,26]. Importantly, patients with chronic drug-resistant epilepsy involving the medial temporal region manifest deficits in emotion recognition even before surgery [1,27]. Recently, we reported facial emotion recognition abilities in a large cohort of 140 patients with chronic medial temporal lobe epilepsy (MTLE) evaluated across a 5-year period [28]. This study confirmed that widespread deficits in the recognition of negative emotions are common in MTLE. In particular, patients with early onset of seizures/epilepsy and right-sided or bilateral damage were severely impaired in emotion recognition.

To our knowledge, only two studies have investigated the processing of emotional prosody in temporal lobe epilepsy. One

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study evaluated emotional prosody in a small cohort of patients after temporal lobectomy [26]; the other addressed emotional prosody recognition in a group of patients with MTLE with asymmetric amygdala damage [29]. Both studies reported no evidence of impairment in emotional prosody recognition at the group level, but impairments were nevertheless revealed when results for single subjects were analyzed [29]. Hence, considering the role of the amygdala in emotion processing across different modalities [30] and the established deficit in facial emotion recognition in patients with MTLE, the following issues were addressed:

1. We determined if emotion recognition deficits in MTLE extended beyond the domain of facial expressions to the auditory domain (emotional prosody). Moreover, we investigated whether patients impaired in one modality were also impaired in recognizing emotion in the other channel of communication.
2. We determined if emotion recognition performance was related to deficits in cognitive intelligence. Indeed, in previous studies we did not investigate potential correlations between emotion recognition performance and the intelligence quotient (IQ) of patients with MTLE. This point is important to test the hypothesis that emotional intelligence and cognitive intelligence are partly independent of each other [19,31]. Of course, emotion recognition abilities are not a synonym for emotional intelligence, but represent only one aspect, or component, of the more complex construct of what we can call "emotional intelligence."
3. Finally, we determined if emotion recognition performance was correlated to measures of well-being as indexed by depression scales and quality of life psychosocial dimensions. In other words, we investigated whether emotion recognition, as expressed by visual and auditory tests, has psychobehavioral implications.

To test these hypotheses we investigated a new group of 41 patients with MTLE.

2. Methods

2.1. Subjects

Patients were recruited and evaluated over a 3-year period, from August 2007 to July 2010. Subjects reported in previous publications were not included in the study. On the basis of clinical history, neurophysiological, and MRI findings, 41 patients with symptomatic MTLE were selected for this study. The subjects were prospectively recruited from the Epilepsy Centre of the Neuroscience Department, Nuovo Ospedale Civile S.Agostino-Estense, University of Modena and Reggio Emilia (Italy).

All patients were clinically evaluated for possible epilepsy surgery. Noninvasive neurophysiological evaluation was based, in all patients, on interictal EEG recordings and prolonged video/EEG monitoring to document the patient's habitual seizures. Clinical and EEG features of the seizures were analyzed to obtain an objective evaluation of ictal semiology and to establish the cerebral structures involved in the epileptic activity. All patients underwent 3.0-T MRI to investigate the temporal lobe structures in detail. The presence of lesions within the medial temporal lobe, or medial temporal sclerosis (MTS), was evaluated qualitatively by visual inspection of the MR images: both atrophy (on T1-weighted sequences) and increased medial temporal signal intensity (on T2-weighted and FLAIR sequences) were necessary to diagnose MTS. Only patients with clear-cut MRI findings were enrolled in the study. Patients whose MRI results were not clearly diagnostic and those who had cryptogenic epilepsy were not included. Demographic and clinical information are reported in Tables 1 and 2.

Fifty right-handed healthy subjects [32], with no history of neurological or psychiatric illness, participated as healthy controls (control group) (see Table 1).

Table 1
Demographic features of patient and control groups.

Group	n	Sex (M/F)	Age (years)	Right-handed[a]	Years of education
MTLE	41	17/24	48.05 ± 11.50[b]	37	9.41 ± 3.33
Control	50	20/30	34.9 ± 9.18[c]	50	16.10 ± 2.41[c]

[a] Assessed with the Edinburgh Inventory [32].
[b] Mean ± SD.
[c] The groups differed with respect to age ($F[1,89] = 36.4$, $P < 0.001$) and years of education ($F[1,89] = 122.6$, $P < 0.001$).

All subjects gave informed consent to participate in the study. Consent was obtained according to the Declaration of Helsinki, and the local ethics committee approved the study.

2.2. Neuropsychological testing

2.2.1. Facial emotion recognition task

We used a previously published protocol employed by our group in the evaluation of facial expressions [20,28]. Pictures of facial affect, taken from the Ekman and Friesen series [33], were used to prepare a task requiring subjects to match a facial expression with the appropriate verbal label by choosing among five basic emotions: happiness, sadness, fear, disgust, and anger. Five pictures (facial stimuli) were used for each emotion for a total of 25 trials. 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%, anger = 94.4%. Pictures (10 × 13 cm) were presented, one by one, on a sheet of paper. The verbal labels for the five facial expressions were printed under each picture, and the subjects were asked to select the word that best described the emotion shown in each photograph.

2.2.2. Emotional prosody recognition task

A prosodic affect-naming task taken from a previously published protocol conducted at our department [34] was used in the current study. Before the experimental task all patients underwent a basic auditory acuity evaluation in which monaural hearing thresholds for tones from 500 to 8000 Hz were measured. All subjects had normal hearing thresholds as determined by standard audiometric testing.

We carefully designed our stimuli so that they varied only with respect to a single factor of interest: emotional prosody. We used brief Italian sentences (approximately 3 seconds) with a neutral meaning (i.e., Marta is combing the cat) spoken by a male or female performer

Table 2
Clinical and neuropsychological features of the MTLE group (n = 41).

Age at first seizure (years)	18.3 ± 15.75[a]
Age at epilepsy onset (years)	20.72 ± 15.87
Duration of epilepsy (years)	27.65 ± 18.66
Hemisphere of seizure onset	
Right	20
Left	17
Bilateral	4
MRI findings	
Mesial temporal sclerosis	35
DNET/ganglioglioma	4
Cavernoma	2
Measures of intelligence and subjective well-being	
WAIS-R	
Full Scale IQ	92.19 ± 18.62
Verbal IQ	91.92 ± 17.19
WAIS Vocabulary	8.19 ± 3.14
Performance IQ	93.81 ± 19.01
Semantic fluency	39.66 ± 7.78
Beck Depression Inventory	11.44 ± 8.57
Quality of Life in Epilepsy-31	57.63 ± 14.31
Emotional Well-Being	7.99 ± 2.90
Social Function	13.69 ± 4.76

[a] Mean ± SD.