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ORIGINAL RESEARCH

A comparison of facial emotion recognition in patients with early- and late-onset temporal lobe epilepsy

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Abstract

Background: Epilepsy is accompanied by a series of clinical manifestations of frequent and abnormal discharges of brain neurons. Early onset of epilepsy can normally cause severe cognitive, emotional and social impairments. Therefore, the purpose of the present study is to compare the recognition of facial emotions in patients with early- and late-onset temporal lobe epilepsy.
Materials and Methods: In a causal-comparative study, after definitive diagnosis of temporal lobe epilepsy, 80 patients with temporal lobe epilepsy included 40 early- and 40 late-onset are recruited in the study by using purposive convenience sampling. The research instruments were by Ekman test of facial emotion recognition and clinical psychiatric interview based on DSM-V. SPSS 19 analyzed data using multivariate analysis of variance.
Results: The results showed significant differences in response accuracy and reaction time of facial emotion recognition between the two groups of early- and late-onset temporal lobe epilepsy ($p<0.01$). These differences were significant in the response accuracy for recognition of sadness, as well significant differences represented in the reaction time for all six basic emotions (happy, sadness, fear, disgust, anger and surprise).
Conclusion: Patients with early-onset temporal lobe epilepsy performed poorly in recognizing sadness. Furthermore, these patients had a longer reaction time in recognizing facial emotions such as; fear, sadness, anger, disgust, happiness and surprise than patients with late-onset temporal lobe epilepsy.

Keywords: Temporal lobe epilepsy, Emotion, Early-onset, Late-onset, Reaction time

Introduction

Temporal lobe epilepsy (TLE) with a prevalence of 48% is the most common symptomatic focal epilepsy syndrome with distinct clinical and pathological features. In 80% of focal epilepsies, the seizures affect the temporal lobes [1-2]. Some parts of the limbic system, including the amygdala, which is an important part in emotional processing, are located in this lobe. Therefore, the temporal lobe has many functions in emotional processing, as well as in the recording and retrieval of memories [3-7].

The amygdala is a crucial region of the temporal lobe in expressing appropriate automatic responses to emotional stimuli. Functional imaging studies show the role of the amygdala in the processing of facial expressions [8-13].

In TLE patients, the amygdala is often damaged. Since the onset of TLE in childhood is associated with negative effects on the neural development in the brain, patients with early-onset epilepsy struggle with many impairments in cognitive and social functioning [13-14]. Research evidence indicates in TLE patient, impaired recognition of negative emotions occurred especially for visual processing of fear [11-12,16-18].

Additionally, researches on children with TLE have indicated high levels of psychopathological symptoms, such as mood and personality disorders, attention-deficit hyperactivity disorder (ADHD), social problems and autism-like behaviors [10,19-20].

Recognition of facial expressions is one of the social-emotional skills. The ability to express emotions facilitates an appropriate social relationship. Facial emotion recognition is a very important social communication skill, which promotes appropriate interpersonal communications [10,21].

Neurological networks responsible for facial emotion recognition include visual cortex, amygdala, orbitofrontal cortex and insula, basal ganglia and prefrontal cortex. The amygdala, which is an important area for evaluating emotional stimuli (especially fear and threat stimuli), is damaged in TLE patients [22-23].

The neural networks for emotional processing are naturally developed from infancy to late adolescence. Studies have shown that the maturation of the amygdala occurs during adolescence. Studies have also shown that, in the two ages of 5 and 15-16, the abilities to perceive and describe facial expressions are developed [10, 24-26].

Given the problems that TLE patients encounter in their social relationships, the impairments in their social and emotional skills should be thoroughly evaluated during adulthood. Therefore, the purpose of the present study was to comparatively evaluate the facial emotion recognition skills in adult patients with early- and late-onset TLE in both response accuracy and reaction time of facial emotion recognition.

Materials and Methods

In a causal-comparative (post-event) study, some patients were recruited during their visits to Chamran Hospital, Iranian Clinical Epilepsy Association and Shohadaye Tajrish Hospital. The recruitment was conducted using the purposive convenience sampling after the definitive diagnosis of TLE by neurologists according to some inclusion criteria. After a psychiatric interview to rule out severe psychiatric disorders and signing a written consent for participating in the study, the participants were assigned to two groups based on their age of epilepsy onset. Indeed, 40 patients under 6 years of age were assigned to the early-onset epilepsy group and 40 patients over 6 years of age to the late-onset epilepsy group.

The inclusion criteria were: 1) an age between 18 and 65 years; 2) a minimum of high school education; 3) having one type of TLE. The exclusion criteria were: 1) having severe mental and personality disorders; 2) drug use and dependence; 3) unwillingness of patients to participate in the study for any reason.

Psychiatric clinical interview based on DSM-V: Psychiatric interviews were conducted on all participants for diagnosing severe mental, personality and substance-related disorders.

Facial emotion recognition test:

This test used a set of 36 facial pictures for measuring the six basic emotions (happiness, disgust, anger, fear, sadness and surprise). This set was adapted from the Ekman and Friesen series of pictures of facial affect. The subjects observed the pictures on a computer display and responded verbally to each picture. A correct answer scored 1 and a wrong answer

zero, so the overall score of everyone was between 0 and 36. The test-retest reliability coefficient of this test was reported 0.85 over a one-week interval [27]. In another study, the Cronbach's alpha of this test was 0.79, as reported by Abolghasemi [28].

In addition, descriptive statistics (mean, standard deviation and frequency distribution) and inferential statistics of the multivariate analysis of variance (MANOVA) were conducted by using the SPSS ver. 19 for Windows (IBM SPSS Inc., Armonk, NY, USA).

All procedures of the current study are following the ethical standard of the institutional and national research committee. some Ethical considerations of this study were; 1-Obtaining informed consent from the subjects 2-Non-disclosure of subjects' personal and identity characteristics 3-Reassuring the subjects to keep their data confidentially 4-Describing the subject's performance in the tests as qualitatively if desired.

Results

The results of the descriptive study of demographic variables were obtained for patients with an average age of 45 years, a standard deviation of 3.42, predominantly male (75.2%), single (58.1%), below high school education (61%), unemployed (78.9%) and with lower and middle socioeconomic statuses (87.5%). The two groups of early- and late-onset TLE showed no significant differences in the demographic variables.

Table 1 shows the mean scores of facial emotion recognition accuracy and the reaction time of facial emotion recognition in the two groups (early- and late-onset TLE). By comparing the mean scores of facial emotion recognition accuracy in the facial emotion recognition of happiness, disgust, anger, fear, sadness and surprise, it was shown that the late-onset TLE patients had higher scores than the early-onset TLE group. A comparison of the mean scores of the reaction time of facial emotion recognition showed that the early-onset TLE had higher reaction times than the late-onset TLE patients.

Table1. Mean scores and standard deviation of the facial emotion recognition accuracy and the reaction time in the early- and late-onset TLE group

Variables	Early onset TLE group		Late onset TLE group	
	Mean	SD	Mean	SD
Happy	5.66	0.54	5.76	0.62
Disgust	1.76	1.22	2.16	1.28
Fear	1.50	1.27	2.06	1.25
Anger	2.80	1.47	3.06	1.59
Sadness	3.86	1.59	4.90	0.92
Surprise	3.90	1.06	4.43	1.69
reaction time of happy	31.10	7.14	22.35	7.74
reaction time of Disgust	39.62	8.51	33.15	12.47
reaction time of Fear	52.19	15.53	40.56	19.71
reaction time of Anger	39.49	9.23	31.78	12.31
reaction time of Sadness	34.20	8.52	30.91	10.78
reaction time of Surprise	34.64	10.90	26.97	8.33

Kolmogorov-Smirnov test of normality was used for the variables of the study. The non-significance of the test indicated that all studied variables had normal distribution ($p<0.05$). Then MANOVA was used to investigate the significant differences between the two groups. As shown in Table 2, the F ratio is significant at the 95% confidence level. Therefore, the groups (early- and late-onset TLE) have a statistically significant difference in at least one of the dependent variables (facial emotion recognition accuracy).

Table 2. The results of MANOVA test of the facial emotion recognition accuracy in the early- and late-onset TLE group

Effect	Tests	Value	F	Hypothesis df	Error df	P-Value	Partial Eta Square
Group	Pilla's Trace	0.25	2.97	6	53	0.014	0.252
	Wilk's Lambda	0.74	2.97	6	53	0.014	0.252
	Hoteling's Trace	0.33	2.97	6	53	0.014	0.252
	Roy's Largest Root	0.33	2.97	6	53	0.014	0.252

In order to find out which variable of facial emotion recognition accuracy had a significant difference between the two groups, we investigated the between-subject effects. As seen in Table 3, the between-subject effects for facial emotion recognition were statistically significant for sadness in the early- and late-onset epilepsy ($p<0.05$). In other words, when it came to this emotion, the facial emotion recognition accuracy in patients with early-onset TLE was poorer than those with late-onset TLE.

Table 3. The results of between-subject effects of the facial emotion recognition accuracy in the early- and late-onset TLE group

Source	Dependent Variable (accuracy response)	Type III Sum of Squares	Df	Mean Square	F	P-Value	Partial Eta Squared
Group	Happy	0.15	1	0.15	0.43	0.513	0.007
	Disgust	2.40	1	2.40	1.52	0.222	0.026
	Fear	4.81	1	4.81	2.99	0.089	0.049
	Anger	1.06	1	1.06	0.45	0.504	0.008
	Sadness	16.01	1	16.01	9.46	0.003	0.140
	Surprise	4.26	1	4.26	2.13	0.150	0.035
Error	Happy	20.03	58	0.34			
	Disgust	91.53	58	1.57			
	Fear	93.36	58	1.61			
	Anger	136.66	58	2.35			
	Sadness	98.16	58	1.69			
	Surprise	116.06	58	2.00			

For investigating the significance of differences between the two groups of early- and late-onset epilepsy in the reaction time of facial emotion recognition, the results of the MANOVA for the reaction time variable are presented in Table 4. From this table, the obtained F ratio at the 99% confidence level is significant. Consequently, the groups (early- and late-onset) differ significantly in at least one of the dependent variables (reaction time of facial emotion recognition).

Table 4. The results of MANOVA test of reaction time of facial emotion recognition in the early- and late-onset TLE group

Effect	Tests	Value	F	Hypothesis df	Error df	P-Value	Partial Eta Square
Group	Pilla's Trace	0.39	5.79	6	53	0.001	0.396
	Wilk's Lambda	0.60	5.79	6	53	0.001	0.396
	Hoteling's Trace	0.65	5.79	6	53	0.001	0.396
	Roy's Largest Root	0.65	5.79	6	53	0.001	0.396

For investigating the significance of the difference in the reaction time variables, the between-subject effects of all emotions at the $p<0.05$ level are presented in Table 5. That is, the reaction times for the facial emotion recognition (happiness, disgust, sadness, anger, fear and surprise) are longer in early-onset than late-onset TLE patients.

Table 5. The results of between subject effects of reaction time of facial emotion recognition in the early- and late-onset TLE group

Source	Dependent Variable (reaction time(s))	Type III Sum of Squares	Df	Mean Square	F	P-Value	Partial Eta Squared
Group	Happy	1149.83	1	1149.83	20.69	0.000	0.263
	Disgust	628.94	1	628.94	5.51	0.022	0.087
	Fear	2027.69	1	2027.69	6.43	0.014	0.100
	Anger	891.35	1	891.35	7.52	0.008	0.115
	Sadness	162.55	1	162.55	1.71	0.195	0.029
	Surprise	881.43	1	881.43	9.35	0.003	0.139
Error	Happy	3222.67	58	55.56			
	Disgust	6613.95	58	114.03			
	Fear	18269.56	58	314.99			
	Anger	6867.86	58	118.41			
	Sadness	5485.57	58	94.57			
	Surprise	5466.85	58	94.25			

Discussion

Facial emotion recognition in patients with early-onset TLE is poorer than in those with late-onset TLE. The findings of the present study showed that there was a significant difference in the accuracy of recognizing sadness in early- and late-onset TLE patients. When it came to the reaction time of facial emotion recognition, there was a significant difference between the two groups for all six basic emotions (happiness, disgust, sadness, anger, fear and surprise). Actually, the reaction times of facial emotion recognition for all six basic emotions were longer in patients with early-onset TLE than in those with late-onset TLE; moreover, the differences were greater in fear, sadness and disgust.

The results of the present study on facial emotion recognition in patients with early- and late-onset epilepsy are in good agreement with the results of the previous studies [10,11,29-32]. Of course, in different studies, there have been no specific onset ages to be attributed to early and late epilepsies [11, 32-38]. Majority of studies considered the age of onset of TLE as same as the current study [11, 32, 35-38]. As well, Hlobil [39] suggested that facial emotion recognition in children lower than 6 years old have more dysfunctions versus the others more than this age.

In addition, in natural growth, the neural networks for emotional processing are developed from infancy to late adolescence. Functional imaging studies have shown that the functional development of the amygdala occurs during adolescence. Growth studies on children's ability to assess and name facial emotions have shown a progressive

improvement between the ages of 5 and 15-16; however, happiness can be accurately recognized even earlier [26].

Patients with epilepsy have impaired emotional processing and interpersonal skills. Seizures and brain injuries can impair emotional processing. In addition, early-onset of epilepsy causes poorer emotional processing in children less than six years of age. Impaired emotional processing can be inferred through facial clues. A recent study showed some deficits in children with TLE [32].

Meletti [11] studied the ability to process the facial emotions in subject's resistant to focal epilepsies (especially TLE) treatment. Data showed that seizures with fever in early-onset epilepsy were strongly associated with impaired emotion recognition.

Tanaka [29] have also shown that, for the case of an early-onset epilepsy in the right or both hemispheres of the brain, the emotional processing impairments of fear, sadness and disgust are more considerable than anger and happiness.

Evaluation of facial emotion recognition abilities in a group of 140 patients with chronic mesial temporal lobe epilepsy (MTLE) over 5 years showed that there are extensive deficits in recognizing negative emotions in MTLE patients. In particular, patients with early-onset epileptic seizures and right or bilateral lesions have more severe emotion deficits [31].

In a study by Amlerova et al., it was shown that emotion recognition and social cognition in TLE patients were influenced by some variables, such as early-onset epilepsy, longer duration of the disease and history of brain injury during early childhood [30].

Lack of agreement on specific onset ages for early and late TLE is one of the limitations of this study. Most of the participants in the study were men with low education and lower or middle socioeconomic status. Indeed, these differences in the gender and socio-cultural factors limit the generalization of the research findings to women and higher socioeconomic status (prosperous patients).

It is suggested that future studies may investigate larger and more homogeneous (gender and socioeconomic status) samples of TLE patients. Moreover, unilateral or bilateral damage regions and a more precise determination of the onset time (not only relying on patients' retrospective history) can also be considered. Finally, other emotional functions in early- and late-onset TLE can be evaluated to determine the extent of functional impairments in these two TLE groups.

Conclusions

The findings of the present study showed that there was a significant difference between the two groups of patients with early- and late-onset TLE in the response accuracy and reaction time of facial emotion recognition.

Conflict of interest

The authors have no conflict of interest to declare.

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