Advances in Nursing and Midwifery Original Article
Summer 2020, Volume 29, Issue 2 (12-18)

A Comparison of Facial Emotion Recognition in Patients with Temporal Lobe Epilepsy and Non-epileptics

Abbas Masjedi Arani [1], **Sepideh Batebi** [1], **Behrooz Dolatshahi** [2,*], **Mojtaba Azimian** [3]

[1] Department of Clinical Psychology, Faculty of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2] Department of Clinical Psychology, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran
[3] Department of Clinical Sciences, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

**Corresponding author: Behrooz Dolatshahi, Department of Clinical Psychology, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran. E-mail: dolatshahee@yahoo.com*

DOI: 10.29252/anm-28144

Submitted: 09-12-2019
Accepted: 19-02-2020
Published: 15-04-2020

Keywords:
Epilepsy
Temporal Lobe Epilepsy
Emotion
Reaction Time

How to cite:
Batebi S, Dolatshahi B, Azimian M, Masjedi Arani A. A Comparison of Facial Emotion Recognition in Patients with Temporal Lobe Epilepsy and Non-epileptics. *Adv Nurs Midwifery*. 2020;29(**2**):12-18. doi: 10.29252/anm-28144

Abstract

Introduction: Temporal lobe epilepsy (TLE) is related to the mesial temporal lobe structures such as the hippocampus, amygdala, and Parahippocampal gyrus. In patients with TLE, the amygdala complex is a component of the temporal lobe that is damaged. Previous studies on emotional processing have proven deficits due to amygdala damage in these patients. The present study compares the facial emotion recognition in patients with temporal lobe epilepsy and healthy controls. It was hypothesized that the TLE group have more dysfunctions than non- people with epilepsy.

Methods: In this comparative study, 120 subjects, including 60 patients with a definite diagnosis of the temporal lobe and 60 non-epileptic individuals, were recruited using purposive sampling. The patient group was chosen from the Chamran hospital and Iranian Epilepsy Association, Tehran, Iran. The research data were collected by the Ekman computer test of facial emotion recognition. This test uses 36 images to measure the six basic emotions (i.e., happiness, disgust, anger, fear, sadness, and surprise); these images were adapted from the Ekman and Friesen series of images. The data were analyzed using multivariate analysis of variance by SPSS Statistics 19-IBM in two levels of response accuracy and reaction time in TLE patients and healthy individuals.

Results: Data analysis showed a significant difference in the response accuracy of facial expressions of happiness, disgust, anger, fear, sadness, and surprise in patients with TLE ($P < 0.01$). Furthermore, recognizing emotions of fear, disgust, and anger in patients with TLE was more inadequate. When it came to the reaction time of emotion recognition, the TLE patients showed a higher functional impairment than the healthy group ($P < 0.01$). The reactions to fear and disgust were notably slower than other emotions.

Conclusions: The results showed more inaccurate facial emotion recognition of fear, disgust, and anger inferred from facial expressions. Moreover, the reaction time response of facial emotion recognition for all six emotions was slower, compared to non-epileptics. Assessing the emotional recognition dysfunction through this measurement can facilitate recognizing the emotional deficiency regarding social communication in TLE patients. Psychological dysfunction can be a predictor of not a good response to the treatment, more frequency of seizures, and worse quality of life in these patients.

INTRODUCTION

Temporal lobe epilepsy (TLE) is a type of epilepsy-related to the mesial temporal lobe structures, such as the hippocampus, amygdala, and parahippocampal gyrus. In patients with TLE, the amygdala complex is a component of the temporal lobe damaged along with the hippocampus [1-3]. In the mesial temporal sclerosis, loss of neurons and gliosis around the hippocampus, entorhinal and amygdala complex have

been reported. The amygdala damage occurs in patients with TLE [4, 5]. The amygdala plays an essential role in necessary emotional development, and there is some evidence of the response of the amygdala, as a biological indicator, to negative emotions [6-8]. Moreover, the amygdala, as a part of the brain that responds preferentially to threatening facial expressions (fear and anger), is highly associated with the orbitofrontal cortex while responding to social threats. While the amygdala can act as a threat investigator, it has a crucial role in evaluating social risks [9].

Patients with TLE have maladaptive social cognitions, some of which correspond to interpreting facial expressions and emotional processing. Emotional processing deficits cause inconsistency in psychosocial, emotional, and interpersonal adjustment [5], lower quality of life [10, 11], and higher rates of depression and anxiety in TLE patients [12, 13]. Patients with TLE have emotional problems, such as fear and anxiety. Some studies have shown that these patients have an attentional bias towards threat-related stimuli than the control group. This attentional bias can lead to emotional vulnerability and seizure in these patients [14, 15].

Emotional recognition ability is an essential component of nonverbal communication and a fundamental skill for successful adaptation to environmental manipulation, which is a significant factor in establishing successful and consistent interpersonal relationships. Anomalous recognition of facial emotional expressions is a critical factor in poor relationships and changes in adaptive behavior. As explained above, understanding and recognizing the emotions of others is an essential factor in social communication. Because of the importance of facial emotion expressions in social interaction, deficiencies in these expressions, to a large extent, can adversely affect the communication quality [16-19]. Several studies have shown that TLE patients have impaired facial emotion recognition ability. This impairment has been reported more commonly in negative emotions, such as fear and anger [14, 20-22]. However, various studies have mostly agreed on impairment in fear recognition. Furthermore, there has been a disagreement over recognizing other negative emotions, such as anger, disgust, sadness, and surprise [14, 23-25].

Although more studies suggested the deficiency in facial emotion recognition, some researches presented some disagreement of dysfunction in some negative emotions, such as sadness, disgust as well as some neutral emotions such as surprise. Moreover, no research has been conducted in Iran on emotional function, especially facial emotion recognition in patients with TLE. Therefore, the purpose of this study is to investigate facial emotion recognition in patients with TLE and to compare them with non-epileptic individuals.

METHODS

In a causal-comparative (post-event) study, 60 patients with TLE were recruited through purposive sampling during their visits to Chamran Hospital (neurology clinics, 2017) and the Iranian Epilepsy Association. Moreover, 60 non-epileptic individuals from the general population without any epileptic background were assigned to the control group. Inclusion criteria were: 1) not having mental retardation; 2) age between 20-50 years; 3) having high school education or higher; 4) no background of severe psychiatric disorders; 5) no concurrent use of antipsychotic and antiepileptic medications; 6) no dependence on drug and alcohol; 7) Another inclusion criterion for the patient group was having any type of TLE and for healthy individuals no medical history of any kind of epilepsy.

After initial medical evaluation by neurologists, performing cerebral electroencephalography, and definitive diagnosis of TLE based on clinical examination of patients during their visits to Chamran Hospital and the Iranian Epilepsy Association, a psychiatric interview session was held for each individual to rule out severe mental and substance use disorder. Finally, after signing a consent form for participating in the study, the participants were evaluated by the Ekman computer test of facial emotion recognition. The control group was assessed by a psychiatric interview and the computer test of facial emotion recognition in the neurology clinic of Chamran hospital.

DSM-V-based Psychiatric Clinical Interview

This interview was conducted by clinical psychologists based on DSM-V to rule out severe mental and substance use disorders.

Facial Emotion Recognition Test

This test uses 36 images to measure the six basic emotions (i.e., happiness, disgust, anger, fear, sadness, and surprise); these images were adapted from the Ekman and Friesen series of images. Each image is portraying one of the six emotions and is presented on the screen for 300 ms. Subjects see the pictures on a computer screen and express their answers by clicking on the appropriate button. A correct answer score one and a false reply zero; the scores of subjects range between 0 and 36, and the reaction time of the responses recorded. The test-retest reliability over one week was reported at 0.85 [26]. In the Iranian sample, Cronbach's alpha of this test was obtained at 0.79 [27]. Additionally, the descriptive statistics (mean, variance, standard deviation, and frequency) and the inferential statistics of multivariate analysis of variance (MANOVA) were used to analyze the data using the SPSS 19–IBM.

RESULTS

The results of the demographic variables of the epileptic patients showed that most of the samples were male (66.7%), single (56.7%), high school graduate/dropout (55%), employed (53.3%), and of middle socioeconomic status (76.7%). In the non-epileptic group, most subjects were male (53.1%), 58.3% had bachelor's and master's degrees, 57.1% were married, 60% were employed, and 70% were of middle socioeconomic status. There was no significant difference between the groups in terms of demographic variables, and the groups were homogeneous.

Table 1 shows the mean scores of facial emotion recognition accuracy and the two groups (patients with TLE and non-epileptics). Based on these results, the mean score of facial emotion recognition accuracy of non-epileptics was higher than TLE patients for all the emotions, i.e., happiness, disgust, anger, fear, sadness, and surprise. The mean reaction time of facial emotion recognition in the epileptic group was higher than the non-epileptics for happiness, disgust, anger, fear, sadness, and surprise.

Table 1. Facial emotion recognition accuracy and reaction time scores of patients with temporal lobe epilepsy and non-epileptic

Variables	TLE group		Non-epileptic group	
	Mean	SD	Mean	SD
Happy	5.71	0.58	5.98	0.12
Disgust	1.96	1.26	4.75	1.08
Fear	1.78	1.29	4.83	0.90
Anger	2.93	1.52	4.95	0.87
Sadness	4.38	1.39	5.30	0.82
Surprise	4.16	1.42	4.91	0.90
Reaction time of happy	26.73	8.60	21.71	3.00
Reaction time of Disgust	36.39	11.07	29.35	5.57
Reaction time of Fear	46.37	18.54	21.16	4.68
Reaction time of Anger	35.63	11.46	3.10	6.65
Reaction time of Sadness	32.55	9.78	29.21	6..73
Reaction time of Surprise	30.80	10.37	27.22	6.60

Table 2. Results of MANOVA test of facial emotion recognition accuracy scores in the TLE group and non-epileptics

Tests	Value	F	Hypothesis df	Error df	P-Value	Partial Eta Square
Pilla's Trace	0.82	85.51	6	113	0.001	0.82
Wilk's Lambda	0.18	85.51	6	113	0.001	0.82
Hoteling's Trace	4.54	85.51	6	113	0.001	0.82
Roy's Largest Root	4.54	85.51	6	113	0.001	0.82

Table 3. Results of between-subject effects of the accuracy of facial emotion recognition in TLE group and non-epileptics

	Type III Sum of Squares	Df	Mean Square	F	P-Value	Partial Eta, Squared
Group						
Happy	2.13	1	2.13	11.89	0.001	0.092
Disgust	232.40	1	232.40	168.05	0.001	0.587
Fear	279.07	1	279.07	224.75	0.001	0.656
Anger	122.00	1	122.00	78.85	0.001	0.401
Sadness	25.20	1	25.20	19.21	0.001	0.140
Error						
Surprise	16.87	1	16.87	11.78	0.001	0.091
Happy	21.16	118	0.17			
Disgust	163.18	118	1.38			
Fear	146.51	118	1.24			
Anger	182.58	118	1.54			
Sadness	154.78	118	1.31			
Surprise	168.91	118	1.43			

Table 4. Results of the MANOVA test of the reaction time of facial emotion recognition in the groups

	Value	F	Hypothesis df	Error df	P-Value	Partial Eta Square
Pilla's Trace	0.56	24.16	6	113	0.001	0.56
Wilk's Lambda	0.43	24.16	6	113	0.001	0.56
Hoteling's Trace	1.28	24.16	6	113	0.001	0.56
Roy's Largest Root	1.28	24.16	6	113	0.001	0.56

It was necessary to evaluate the normality of the distributions of the variables, so the Kolmogorov-Smirnov test was used; the significance level of this test for the variables was more extensive than 0.05, so MANOVA could be used to analyze the results. The results of the MANOVA test for the response accuracy of facial emotion recognition are presented in Table 2.

As shown in Table 2, the obtained F ratio had significance at the level of 99%. As a result, the groups (of patients with TLE and non-epileptics) had a

significant difference, at least in one of the dependent variables (facial emotion recognition), so the hypothesis was confirmed. The recognition of facial emotions (happiness, disgust, anger, fear, sadness, and surprise) was different for TLE patients and non-epileptic individuals.

However, it was not possible to specify which of the dependent variables caused the difference. Accordingly, in the following, we discuss which facial emotion (happiness, disgust, anger, fear, sadness, or surprise) has been affected separately. Then, the test results of between-subjects effects are presented. Table 3 shows that the results of between-subject effects for the accuracy of facial emotion recognition (happiness, disgust, anger, fear, sadness, and surprise) of the groups was significant at the $P < 0.05$ level. In other words, recognition of these facial emotions was more adversely affected in TLE patients.

Results of reaction time to emotions in Table 4 showed 99% significance for the obtained F ratio. Consequently, the groups (of patients with TLE and non-epileptics) differ in at least one of the variables (reaction time of facial emotion recognition) and have statistically significant differences. The reaction times of recognition of facial emotions (happiness, disgust, anger, fear, sadness, and surprise) are different in patients with TLE compared to non-epileptic individuals.

To investigate which of the facial emotions is distinctly influenced by the independent variable (groups), the test results of between-subjects effects are presented in Table 5. According to this table, recognizing happiness, disgust, anger, fear, sadness, and surprise were significant at the $P<0.05$ level between TLE and non-epileptic groups. In other words, the reaction time for recognizing all six facial emotions was slower in the TLE patients compared to the healthy group, especially for knowing fear and disgust.

Table 5. Results of between-subject effects of the reaction time of facial emotion recognition in the TLE group and non-epileptics

Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	P-Value	Partial Eta, Squared
Group						
Reaction time of Happy	755.71	1	755.71	18.17	0.001	0.133
Reaction time of Disgust	1486.38	1	1486.38	19.31	0.001	0.141
Reaction time of Fear	19063.80	1	19063.80	104.17	0.001	0.469
Reaction time of Anger	918.31	1	918.31	10.44	0.002	0.081
Reaction time of Sadness	334.63	1	334.63	4.74	0.031	0.039
Reaction time of Surprise	384.24	1	384.24	5.08	0.026	0.041
Error						
Reaction time of Happy	4905.39	118	41.57			
Reaction time of Disgust	9079.69	118	76.94			
Reaction time of Fear	21593.91	118	182.99			
Reaction time of Anger	10373.87	118	87.91			
Reaction time of Sadness	8326.67	118	70.56			
Reaction time of Surprise	8921.85	118	75.60			

DISCUSSION

This study was conducted to evaluate facial emotion recognition in patients with TLE. The results showed that, in terms of recognition accuracy and reaction time, the TLE patients had a more reduced response than non-epileptics. In these patients, the values of error were higher in recognizing the emotions of fear, disgust, and anger, respectively. Moreover, the reaction times of emotion recognition in these patients were slower than that of healthy individuals in all the six emotions; slowness of the reaction in recognition of fear and disgust was higher than that of the other emotions.

Due to the amygdala damages in TLE patients [2, 14, 28-30] and dysfunction in emotional recognition in bilateral amygdala damage [31-33], it is expected that the emotional recognition to be more dysfunctional in these patients compared to non-epileptics. The results of this study show more dysfunction of facial emotion recognition in TLE groups compared to non-epileptics. The results of the present study are in agreement with the findings of the previous studies. Other studies have also shown deficits in recognition of negative emotions, such as fear, disgust, and anger [14, 20-22, 34]. Moreover, in the present study, more deficiency in recognizing fear, loathing and hatred and slower reaction to all emotions, especially fear and disgust, were found. More weakness in understanding negative emotions related to visual and auditory processing has been presented in another study [35] that confirms the present results. Other studies showed that the difficulties in recognizing negative emotions, such as sadness, disgust, and fear, are prevalent in patients with right mesial temporal lobe epilepsy [36]. The response accuracy of recognition of sorrow was not significant compared to non-epileptics in the study. In contrast, the slower reaction to sadness in the TLE group was considerable compared to the non-epileptics. Sedda [24] found that recognition of negative emotions in right-TLE patients is more deficient compared to left-TLE patients.

Research on the mesial temporal lobe epilepsy showed that dysfunctions in emotional recognition lead to higher social maladjustments [20]. In a study by Amlerova [37], more inadequate emotional recognition and social cognition impairments were confirmed in TLE patients than healthy controls. Tanaka [25] showed that facial emotion recognition impairments could be identified in mesial temporal lobe epilepsy and post temporal lobotomy versus healthy controls. A systematic review of emotion recognition in temporal lobe epilepsy [14] pointed to conflicting reports of the studies about the emotion recognition deficits. Still, all studies deal with the dysfunction of fear recognition as presented in visual stimuli either in pre-surgical and post temporal lobotomy TLE patients.

Sprengelmeyer [38] showed that, in patients with bilateral amygdala damage, there is an impaired recognition of the expression of fear and a decrease in the level of anxiety experienced in everyday life. In a study by Yamada [39], it was shown that the patients with TLE before the surgery perceived the emotional expressions as fear, sadness, and anger. In another study, these patients were more impaired in processing emotions such as fear, grief, and disgust than anger and happiness [25].

However, the findings of the present study on the emotion of disgust are not in line with the results of previous studies, where it was shown that these patients had the highest impairment in recognizing sadness [25], surprise [23], and the lowest impairment in recognizing disgust [40]. According to the literature, most studies have shown the TLE patient's dysfunction in understanding negative emotions, such as fear, disgust, and anger [20-22, 24, 34].

Concerning the limitations of this study, only one dysfunction of emotional processing in patients with TLE was investigated. Therefore, in future studies, there is a need for investigating the other types of emotional processing of TLE patients in social environments and contexts before and after the onset of epilepsy. Furthermore, more clinical questionnaires and interviews are needed to assess the level of emotional functioning of TLE patients for adaptation to social and family conditions. The present study performed preliminary investigations on the sensitive components of patients with TLE, so further researches are needed to investigate and compare the extent of dysfunction of emotional functioning in patients with early- and late-onset epilepsy, as well as patients with focal and generalized epilepsies and left- and right-TLE. Moreover, some longitudinal studies should assess emotional recognition function before and after lobotomy by some other ecologically reliable instruments and compare emotion dysfunction in the patient's everyday activities. Finally, the results of psychological studies on TLE patients may lead to complementary treatments for emotion regulation and emotion-focused psychotherapy and prevent social maladjustment.

CONCLUSIONS

Understanding the psychopathological components in TLE is crucial to recognize the essential elements and perpetuating factors that exacerbate this disease. This study was preliminary research on emotion recognition processing in Iranian TLE patients. The purpose of this study was to compare the dysfunction of facial emotion processing in TLE patients versus the non-epileptic group. Also, considering the accuracy and reaction time of response, the findings of the present study implied that facial emotion recognition in TLE patients is more dysfunctional compared to non-epileptic individuals. Facial emotion recognition tests can help to recognize and assess the impairment of emotional recognition of TLE patients in interpersonal relationships. Emotion impairment can be related to developing a patient's social maladjustments and disability in social communication. Furthermore, in TLE patients with dysfunctional emotion recognition (as a core factor of comorbid disorders such as depression and anxiety), the response to treatment, frequency of seizures, and quality of life can be exacerbated. Therefore, by assessing the emotional deficiency of TLE patients, neurologists can refer TLE patients to clinical psychologists or other mental health services for further interventions such as psychotherapy based on emotion regulation as a supplementary treatment along with usual medical treatment.

In future studies, the effects of emotional dysfunction on the exacerbation of seizures should focus on patients affected by TLE. These effects may include other aspects of emotional processing and emotional dysregulation involving social maladjustment in TLE patients. Some studies will be needed regarding the psychological dysfunction of TLE patients in social interactions compared to other types of focal and generalized epilepsy. Additionally, future studies may investigate the emotional lateralization models of emotional dysfunctions in the right hemisphere versus left hemisphere temporal lobe epilepsy.

Ethical Consideration

All procedures of the current study are by the ethical standard of the institutional and national research committee. A Code of Ethics (IR.USWR.REC.1394.231) was received from the Research Committee of the University of Social Welfare and Rehabilitation Sciences, Tehran, Iran. Some ethical considerations of this study were; 1- Obtaining informed consent from the subjects; 2- Non-disclosure of subjects' characteristics and identity; 3- Reassuring the items to keep their data confidentially; 4- Describing

the subject's performance in the tests as qualitatively if desired.

Acknowledgments
We would like to sincerely thank the managers and personnel of the Iranian Epilepsy Association and the Chief Executive Officer (CEO) of Chamran Hospital for their cooperation during the study and the research deputy of Shahid Beheshti School of Nursing and Midwifery who supported researchers.

Author's Contributions
Sepideh Batebi designed and performed experiments, analyzed data, and wrote the paper. Behrooz Dolatshahi supervised the research. Mojtaba Azimian consulted about the research, and Abbas Masjedi Arani provided some suggestions to write the paper.

Conflict of Interest
The authors have no conflicts of interest.

REFERENCES

1. Yilmazer-Hanke D, O'Loughlin E, McDermott K. Contribution of amygdala pathology to comorbid emotional disturbances in temporal lobe epilepsy. J Neurosci Res. 2016;94(6):486-503. **doi:** 10.1002/jnr.23689 **pmid:** 26525920
2. Nakayama Y, Masuda H, Shirozu H, Ito Y, Higashijima T, Kitaura H, et al. Features of amygdala in patients with mesial temporal lobe epilepsy and hippocampal sclerosis: An MRI volumetric and histopathological study. Epilepsy Res. 2017;135:50-5. **doi:** 10.1016/j.eplepsyres.2017.05.010 **pmid:** 28622539
3. Mogi T, Tsunoda T, Yoshino A. Altered upright face recognition and presence of face inversion effect in temporal lobe epilepsy: An event-related potential study. Psychiatry Clin Neurosci. 2019;73(5):269-76. **doi:** 10.1111/pcn.12829 **pmid:** 30734399
4. Toller G, Adhimoolam B, Grunwald T, Huppertz HJ, Kurthen M, Rankin KP, et al. Right mesial temporal lobe epilepsy impairs empathy-related brain responses to dynamic fearful faces. J Neurol. 2015;262(3):729-41. **doi:** 10.1007/s00415-014-7622-2 **pmid:** 25572160
5. Wendling AS, Hirsch E, Wisniewski I, Davanture C, Ofer I, Zentner J, et al. Selective amygdalohippocampectomy versus standard temporal lobectomy in patients with mesial temporal lobe epilepsy and unilateral hippocampal sclerosis. Epilepsy Res. 2013;104(1-2):94-104. **doi:** 10.1016/j.eplepsyres.2012.09.007 **pmid:** 23022178
6. Gaffrey MS, Barch DM, Luby JL. Amygdala reactivity to sad faces in preschool children: An early neural marker of persistent negative affect. Dev Cogn Neurosci. 2016;17:94-100. **doi:** 10.1016/j.dcn.2015.12.015 **pmid:** 26780113
7. Chen S, Deng Z, Xu Y, Long Q, Yang J, Yuan J. Individual Differences in Spontaneous Expressive Suppression Predict Amygdala Responses to Fearful Stimuli: The Role of Suppression Priming. Front Psychol. 2017;8. **doi:** 10.3389/fpsyg.2017.00001
8. Fox AS, Shackman AJ. The central extended amygdala in fear and anxiety: Closing the gap between mechanistic and neuroimaging research. Neurosci Lett. 2019;693:58-67. **doi:** 10.1016/j.neulet.2017.11.056 **pmid:** 29195911
9. Satterthwaite TD, Wolf DH, Pinkham AE, Ruparel K, Elliott MA, Valdez JN, et al. Opposing amygdala and ventral striatum connectivity during emotion identification. Brain Cogn. 2011;76(3):353-63. **doi:** 10.1016/j.bandc.2011.04.005 **pmid:** 21600684
10. Pauli C, Thais ME, Claudino LS, Bicalho MA, Bastos AC, Guarnieri R, et al. Predictors of quality of life in patients with refractory mesial temporal lobe epilepsy. Epilepsy Behav. 2012;25(2):208-13. **doi:** 10.1016/j.yebeh.2012.06.037 **pmid:** 23032134
11. Mathon B, Bielle F, Samson S, Plaisant O, Dupont S, Bertrand A, et al. Predictive factors of long-term outcomes of surgery for mesial temporal lobe epilepsy associated with hippocampal sclerosis. Epilepsia. 2017;58(8):1473-85. **doi:** 10.1111/epi.13831 **pmid:** 28656696
12. Brandalise MH, Barbosa G. Depressive and Anxiety Symptoms Exert Negative Impact on Resilience to Stressful Events in Patients with Refractory Temporal Lobe Epilepsy with Late Seizure Recurrence after Surgery. J Psychol Psychother. 2016;6(3). **doi:** 10.4172/2161-0487.1000269
13. Scott AJ, Sharpe L, Hunt C, Gandy M. Anxiety and depressive disorders in people with epilepsy: A meta-analysis. Epilepsia. 2017;58(6):973-82. **doi:** 10.1111/epi.13769 **pmid:** 28470748
14. Monti G, Meletti S. Emotion recognition in temporal lobe epilepsy: A systematic review. Neurosci Biobehav Rev. 2015;55:280-93. **doi:** 10.1016/j.neubiorev.2015.05.009 **pmid:** 25999121
15. Kotwas I, Micoulaud-Franchi JA, Khalfa S, McGonigal A, Bastien-Toniazzo M, Bartolomei F. Subjective and physiological response to emotions in temporal lobe epilepsy and psychogenic non-epileptic seizures. J Affect Disord. 2019;244:46-53. **doi:** 10.1016/j.jad.2018.10.004 **pmid:** 30312840
16. García-Villamisar D, Rojahn J, Zaja RH, Jodra M. Facial emotion processing and social adaptation in adults with and without autism spectrum disorder. Res Autism Spectr Disord. 2010;4(4):755-62. **doi:** 10.1016/j.rasd.2010.01.016
17. Farran EK, Branson A, King BJ. Visual search for basic emotional expressions in autism; impaired processing of anger, fear and sadness, but a typical happy face advantage. Res Autism Spectr Disord. 2011;5(1):455-62. **doi:** 10.1016/j.rasd.2010.06.009
18. Scotland JL, McKenzie K, Cossar J, Murray A, Michie A. Recognition of facial expressions of emotion by adults with intellectual disability: Is there evidence for the emotion specificity hypothesis? Res Dev Disabil. 2016;48:69-78. **doi:** 10.1016/j.ridd.2015.10.018 **pmid:** 26546741
19. Griffiths S, Jarrold C, Penton-Voak IS, Woods AT, Skinner AL, Munafo MR. Impaired Recognition of Basic Emotions from Facial Expressions in Young People with Autism Spectrum Disorder: Assessing the Importance of Expression Intensity. J Autism Dev Disord. 2019;49(7):2768-78. **doi:** 10.1007/s10803-017-3091-7 **pmid:** 28361375
20. Broicher SD, Kuchukhidze G, Grunwald T, Kramer G, Kurthen M, Jokeit H. "Tell me how do I feel"--emotion recognition and theory of mind in symptomatic mesial temporal lobe epilepsy. Neuropsychologia. 2012;50(1):118-28. **doi:** 10.1016/j.neuropsychologia.2011.11.005 **pmid:** 22108441
21. Realmuto S, Zummo L, Cerami C, Agro L, Dodich A, Canessa N, et al. Social cognition dysfunctions in patients with epilepsy: Evidence from patients with temporal lobe and idiopathic generalized epilepsies. Epilepsy Behav. 2015;47:98-103. **doi:** 10.1016/j.yebeh.2015.04.048 **pmid:** 25982884
22. Steiger BK, Jokeit H. Why epilepsy challenges social life. Seizure. 2017;44:194-8. **doi:** 10.1016/j.seizure.2016.09.008 **pmid:** 27756511
23. Dellacherie D, Hasboun D, Baulac M, Belin P, Samson S. Impaired recognition of fear in voices and reduced anxiety after unilateral temporal lobe resection. Neuropsychologia. 2011;49(4):618-29. **doi:** 10.1016/j.neuropsychologia.2010.11.008 **pmid:** 21108955
24. Adolphs R. Recognizing emotion from facial expressions: psychological and neurological mechanisms. Behav Cogn Neurosci Rev. 2002;1(1):21-62. **doi:** 10.1177/1534582302001001003 **pmid:** 17715585

25. Tanaka A, Akamatsu N, Yamano M, Nakagawa M, Kawamura M, Tsuji S. A more realistic approach, using dynamic stimuli, to test facial emotion recognition impairment in temporal lobe epilepsy. Epilepsy Behav. 2013;28(1):12-6. **doi:** 10.1016/j.yebeh.2013.03.022 **pmid:** 23648274
26. Besel LDS, Yuille JC. Individual differences in empathy: The role of facial expression recognition. Personality and Individual Differences. 2010;49(2):107-12. **doi:** 10.1016/j.paid.2010.03.013
27. Abolghasemi A. The relationship between non-verbal behaviors, emotional processing and recognition with positive and negative symptoms in pietients with schizophrenia patient. J Rafsanjan Univ Med Sci. 2013;12(2):89-102.
28. Labudda K, Mertens M, Steinkroeger C, Bien CG, Woermann FG. Lesion side matters - an fMRI study on the association between neural correlates of watching dynamic fearful faces and their evaluation in patients with temporal lobe epilepsy. Epilepsy Behav. 2014;31:321-8. **doi:** 10.1016/j.yebeh.2013.10.014 **pmid:** 24210457
29. Tchekalarova J, Atanasova D, Nenchovska Z, Atanasova M, Kortenska L, Gesheva R, et al. Agomelatine protects against neuronal damage without preventing epileptogenesis in the kainate model of temporal lobe epilepsy. Neurobiol Dis. 2017;104:1-14. **doi:** 10.1016/j.nbd.2017.04.017 **pmid:** 28438504
30. Ayesa-Arriola R, Setién-Suero E, Neergaard KD, Ferro A, Fatjó-Vilas M, Ríos-Lago M, et al. Evidence for Trait Related Theory of Mind Impairment in First Episode Psychosis Patients and Its Relationship with Processing Speed: A 3 Year Follow-up Study. Front Psychol. 2016;7. **doi:** 10.3389/fpsyg.2016.00592
31. Becker B, Mihov Y, Scheele D, Kendrick KM, Feinstein JS, Matusch A, et al. Fear processing and social networking in the absence of a functional amygdala. Biol Psychiatry. 2012;72(1):70-7. **doi:** 10.1016/j.biopsych.2011.11.024 **pmid:** 22218285
32. Meletti S, Cantalupo G, Santoro F, Benuzzi F, Marliani AF, Tassinari CA, et al. Temporal lobe epilepsy and emotion recognition without amygdala: a case study of Urbach-Wiethe disease and review of the literature. Epileptic Disord. 2014;16(4):518-27. **doi:** 10.1684/epd.2014.0696 **pmid:** 25465029
33. Sarkheil P, Zilverstand A, Kilian-Hutten N, Schneider F, Goebel R, Mathiak K. fMRI feedback enhances emotion regulation as evidenced by a reduced amygdala response. Behav Brain Res. 2015;281:326-32. **doi:** 10.1016/j.bbr.2014.11.027 **pmid:** 25461265
34. Gomez-Ibanez A, Urrestarazu E, Viteri C. Recognition of facial emotions and identity in patients with mesial temporal lobe and idiopathic generalized epilepsy: an eye-tracking study. Seizure. 2014;23(10):892-8. **doi:** 10.1016/j.seizure.2014.08.012 **pmid:** 25277844
35. Bonora A, Benuzzi F, Monti G, Mirandola L, Pugnaghi M, Nichelli P, et al. Recognition of emotions from faces and voices in medial temporal lobe epilepsy. Epilepsy Behav. 2011;20(4):648-54. **doi:** 10.1016/j.yebeh.2011.01.027 **pmid:** 21459049
36. Batut AC, Gounot D, Namer IJ, Hirsch E, Kehrli P, Metz-Lutz MN. Neural responses associated with positive and negative emotion processing in patients with left versus right temporal lobe epilepsy. Epilepsy Behav. 2006;9(3):415-23. **doi:** 10.1016/j.yebeh.2006.07.013 **pmid:** 16949873
37. Amlerova J, Cavanna AE, Bradac O, Javurkova A, Raudenska J, Marusic P. Emotion recognition and social cognition in temporal lobe epilepsy and the effect of epilepsy surgery. Epilepsy Behav. 2014;36:86-9. **doi:** 10.1016/j.yebeh.2014.05.001 **pmid:** 24892754
38. Sprengelmeyer R, Young AW, Schroeder U, Grossenbacher PG, Federlein J, Buttner T, et al. Knowing no fear. Proc Biol Sci. 1999;266(1437):2451-6. **doi:** 10.1098/rspb.1999.0945 **pmid:** 10693814
39. Yamada M, Murai T, Sato W, Namiki C, Miyamoto T, Ohigashi Y. Emotion recognition from facial expressions in a temporal lobe epileptic patient with ictal fear. Neuropsychologia. 2005;43(3):434-41. **doi:** 10.1016/j.neuropsychologia.2004.06.019 **pmid:** 15707618
40. Meletti S, Benuzzi F, Rubboli G, Cantalupo G, Stanzani Maserati M, Nichelli P, et al. Impaired facial emotion recognition in early-onset right mesial temporal lobe epilepsy. Neurology. 2003;60(3):426-31. **doi:** 10.1212/wnl.60.3.426 **pmid:** 12578923