Original Research Articles

Event-Related Potentials in Unipolar Major Depressive Disorder: Psychometric and Neurophysiological Study

M. Saad, M. Al-Khateeb., S. El-Naggar, S. Saleh, and T. Molokhia

Abstract

Discrepancies exist in pervious reports regarding clinical, psychological and electrophysiological features of major depressive disorders. Objectives: The purposes of this work are to estimate the significance of various components of Event-Related Potentials (ERPs) of patients with major depression and to determine if abnormal ERPs are related to cognitive impairment and severity of major depressive disorder. Method: Patients with DSM-IV major depressive disorder (N=30) and normal control subjects (N=30) were assessed for demographic data, severity of depression, cognitive functions and event-related potentials (P300 latency and N100, N200 & P300 amplitudes). Results: Patients with major depression had longer P300 latency, lowered P300, N100 amplitudes and higher N200 amplitude than normal control participants. ERPs abnormalities were associated not only with the severity of depression (assessed by Raskin Depression Rating Scale) but also with cognitive impairment (assessed by Mini Mental State Examination) in major depression. Conclusion: Event-Related Potentials (ERPs) are a useful tool in assessment of the cognitive impairment and severity of major depressive disorder which, in turn, may interpret the relationship between impairment of cortico-striato-pallido-thalamo-cortical pathways and pathophysiology of major depressive disorder.

Key words: *ERPs, MDD.*

Introduction:

The existence of cognitive problems in depressive illness has been known for many years (Kraepelin, 1927; Bleuler, 1972). It has been observed that individuals suffering from major depression are prone to a negativistic bias in cognitive processing (Engel and DeRubeis, 1993). Many studies involving various electrophysiological parameters have been conducted in different psychiatric disorders, e.g. dementia, schizophrenia ... etc., to evaluate their cognitive dysfunction (Himani, et al., 1999).

P300 is an event-related brain potential (ERP) particularly interesting to the study of cognitive processes in normal subjects and in psychopathology, (Hansenne, et al., 2000).

Long-latency auditory event–related (endogenous) potentials have been shown to be delayed in patients with organic cognitive deficits and may be used as an objective measure of cognitive function. The test that has been found to be of clinical use is the P3, or P300, test recorded using an auditory odd ball paradigm. The generators of these potentials are unknown but are presumably in the multi-modal association cortex since similar potentials are recorded regardless of the stimulus modality used (Goodin, et al., 1994).

Studies of event related brain potential (ERP) in depressive disorders showed variable results. Some studies recorded a reduction in P300 amplitude (Diner et al., 1985; Blackwood et al., 1987; Gangadhar et al., 1993), while others have reported no change (Roth et al., 1981; Sara et al., 1994). A major source for these controversial results could result from the diversity of depressed patients included in the different studies. Supporting this assumption, impulsivity, blunted affect, suicidal behavior and psychotic features significantly influence P300 amplitude (Hansenne et al., 2000).

This work has been conducted to estimate the significance of various components of ERPs i.e. N100, N200 and P300 of patients with major depressive disorder (MDD) and to determine if abnormal ERPs are related to cognitive impairment and severity of this disorder.

Methods:

This study was conducted in the outpatient and inpatient units of Psychiatric Department as well as in the electro- physiology unit of Neurology Department at Mansoura University Hospital. In December 2000 to May 2001.

Subjects:

Thirty consenting patients met DSM-IV criteria for unipolar major depressive disorder (APA, 1994) gave written consents. They were recruited from consecutive attendance to the outpatient unit and admissions to inpatient unit of Psychiatric Department at Mansoura University Hospital. The diagnosis was established by history and mental status examination, as well as by information from relative and friends. They were included if they were right-handed males or females aged 20-45 years, educated with average to above IQ (90–140). Patients were excluded if they were alcohol or substance abusers, with neurological illness, epilepsy, brain injury or severe deafness, with history of hypomanic, manic episode or

electro convulsive therapy during past 6 months. As well as if they are on steroids, anticonvulsant, tranquillizers or any active medication required to other medical disorders e.g. diabetes, hypertension or ischaemic heart disease. Subjects took no psychoactive medications during the study. For those who had been taking antidepressants, a minimum of 4 weeks without medication were required and those who had been taking benzodiazepins their medications were with drawn slowly and they were drug free for a minimum of one week before the study.

Control Group:

Thirty normal healthy controls were recruited from the hospital personnel and attendants of patients. They were interviewed, informed by the details of the research and gave written consents. They were included if they were matched with the patients as regard age, gender, handedness and intelligence. The excluded controls were characterized by one or more of the following causes viz. alcohol or substance abuse, neurological, psychiatric disorders or epilepsy, brain injury, life time history of manic or depressive disorder, life time history of psychotic symptoms or severe deafness.

Tools Used for Evaluation:

1) **Semi-structured sheet,** it includes patients' identification, socioeconomic variables, history of present illness, past history, family history, personal history, premorbid personality, complete physical examination, mental status examination and diagnostic formulation.

2) **Thorough neurological examination,** to exclude physical and neurological etiology, as well as comorbidity with depression.

3) **Raskin Depression Rating Scale:** it is a clinician rated scale developed by Raskin et al. (1969). It measures the severity of a patient's depression as reported by the patient and as observed by the physician, on a five – point scale of three dimension, verbal, report, displayed behavior, and secondary symptoms. The scale has a range of 3 to 15; a normal score is 3 and a depressed score is 9 or more.

4) **Mini Mental State Examination,** it was developed by Folstein et al., (1975) to assess cognitive functions. In this test full points are 30 and it contains 5 subtests as orientation (10 points), registration (3 points), attention and calculation (5 points). All subjects were given psychometric tests by the same medical personnel. Patients and controls were compared for both global scores and subsets scores separately.

5) **Laboratory assessment,** it includes complete blood count (CBC), routine liver and renal function tests, thyroid function tests and urine toxicology screen.

6) **Event-Related Evoked Potential (P300),** the auditory odd-ball paradigm was used for P300 and other recording on Neuropack-4 evoked potential machine (Dantec Keypoint) in a quite, dimly lit, soundproof, air con- ditioned room. Prior to the testing session, all subjects were dully informed and had recording electrodes attached to their scalp using electrode conducting paste. Subjects were fitted with earphones for the presentation of auditory stimuli. Subjects were seated in a comfortable chair. EEG was recorded between 0.1 Hz. The electrodes were placed from Fz and Cz sites with 10-20 Inter- national system, referred to linked ears (A1+A2) with ground electrode on forehead (Fpz). Impedance was measured with Electrode Impedance Meter after application of electrodes to scalp. Electrodes with impedance level greater than 5 kilohms were readjusted by rubbing the scalp with a special abrasive cream. ERP analysis was conducted that allowed for EEG acquisition, baseline correction, artifact rejection, ocular artifact correction and averaging of wave forms. An ocular artifact correction procedure was used to minimize data loss while maximizing the integrity of waveforms. Two auditory stimuli were presented binaurally at 70 db SPL. A low tone, 1000 Hz, (80%) and a high tone, 2000 Hz, (20%) were presented in a pseudo-random order. The rise time and fall time of the tones was 10 ms while plateau time was 100ms. The subjects expected to detect the infrequent tone (2000 Hz) by raising the right index finger. All recordings of depressed patients and from Cz were analyzed. Latencies, amplitudes and duration of N1, P2, N2 & P3 were measured. Peaks of waveforms were marked. The first upward deflection following P1 stimulus artifact was marked as N1, and following downward-upward and downward deflections as P2, N2 and P3, respectively. The P300 latency was considered abnormal if it exceed the predicted value for that age plus 2 standard deviations.

Statistical analysis:

The data of the patients and controls were statistically analyzed using X^2 and "t" test. The level of significance was chosen at ($P<0.05$).

Results:

1. Demographic & clinical features:

Table, (1) describes the demographic features of the studied patients who met DSM-IV criteria for Major depressive disorder in comparison with normal control individuals. As shown in the table, there were no significant differences between patients and control group with respect to age distribution, sex, years of education and marital status.

Discussion:

Event-related potentials (ERPs) time-locked to cognitive decisions are utilized as an objective measure of mental activity. These brain potentials have not yet been widely utilized in the assessment of depressed populations.P300 was first described by Sutton et al. (1965) which is a long latency event related endogenous potential (about 300 ms

after the stimulus onset), presumably presents endogenous processing of external stimuli (Picton, 1992).

In our study the mean latency of P300 in depressive patients, as in fig., 2, was significantly prolonged than that of the healthy control group, as in fig., 1 (t=-3.92, p<0.001) as well as its mean amplitude in depressive patients was significantly lowered than that of healthy controls (t=7.83, p<0.001).

Table (1): Demographic features of depressive group versus control group

Demographic Features	Depressive group (N=30)		Control group (N=30)		X^2
	No	%	No	%	
Age distribution in years					
20-35	10	33.3	16	53.3	1.7
36-45	20	66.7	14	46.7	
Sex					
Male	14	46.7	14	46.7	0.067
Female	16	53.3	16	53.3	
Education					
Primary school	10	33.3	6	20	0.77
Prep school	8	26.7	8	26.7	0.085
Secondary school	6	20	8	26.7	0.093
College	6	20	8	26.7	0.093
Marital status					
Married	16	53.3	18	60	0.068
Divorced	6	20	6	20	0.104
Single	8	26.7	6	20	0.093

Table, (2) displays the clinical features of depressive group. A good number of them 12 (40%) had family history of similar conditions. As regard to the history of the previous similar attacks, it was found that the higher number of the sample 12 (40%) had two previous attacks followed by three previous attacks in 10 (33.3%), while, the rest of patients had one attack and four attacks in equal frequencies i.e. 4 (13.3%) each. Stressful precipitating events preceded depressive attacks in 12 patients (40%). A higher frequency of the sample 12 (40%) had 2-3 months duration followed by 10 (33.3%) of the sample had 0.5-1.5 month duration and 8 (26.7%) of them had 3.5-4 months duration. With respect to the severity of the illness, 12 (40%) of the patients showing severe episodes followed by 10 (33.3%) of them with moderate episodes and 8 (26.7%) of them with mild episodes.

Table(2): Clinical features of the depressives

Clinical Features	N=30	%
Family history		
Positive similar attacks	12	40
Negative similar attacks	18	60
Number of previous attacks		
One attack	4	13.3
Two attacks	12	40
Three attacks	10	33.3
Four attacks or more	4	13.3
Precipitating factors		
Present	12	40
Absent	18	60
Duration of illness per month		
0.5 - 2 months	10	33.3
2 - 3 months	12	40
3 - 4 months	8	26.7
Severity of illness		
Mild	8	26.7
Moderate	10	33.3
Severe	12	40

2- ophysio-logical studies:

Table, (3) shows the psychometric studies of depressive group in comparison with the control group. There were highly significant difference between both groups with respect to cognitive functions measured by the total scores of Mini Mental State Examination Scale
+ P< (t=5.91), and severity of the illness as reflected by the total scores of Raskin Depression Rating Scale
(t= -18.73) p<

Table (3): Psychometric studies of both depressive and control groups

Total scores	Depressive group (N=30)		Control group (N=30)		T
	Mean	SD	Mean	SD	
Mini Mental State Examination	23.1	±2.56	27.0	±1.9	5.91***
Raskin Depression Rating Scale	11.87	±1.74	4.3	±1.46	-18.73***

*** P<0.001

Table, (4) as well as figures display the electrophysiological studies of the depressive group in comparison with the control group. It was evident that highly significant differences were found between both groups with respect to N100 (t= 8.39), N200 (t= -5.49), N 300 amplitude (t= 7.83) and N300 latency (t= -3.92).

Table(4): Electrophysiological studies of both depressive and control groups

Variables	Depressive group (N=30)		Control group (N=30)		T
	Mean	SD	Mean	SD	
N 100	99.7	±12.9	144	±21.6	8.39***
N 200	261.1	±29.1	232	±14.59	-5.49***
P 300 amplitude	9.3	±4.48	18.09	±3.41	7.83***
P 300 latency	387.6	±42.26	352.6	±24.15	-3.92***

***P<0.001

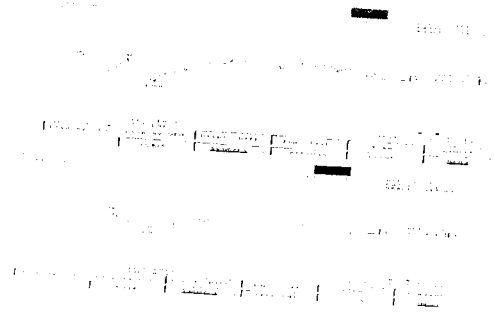

Fig. (1): P300 of patient with major depressive disorder ERP-Auditory (P300) amplitude and latency in normal control and MDD patients.

The amplitude of P300 is increased by many factors, including the subjects attentiveness and the unpredictability of the odd ball stimulus. The lowered P300 amplitude may be due to failure of the depressed patients to extract fully the available information from the stimulus possibly because of the inability to allocate attention to the ERP task (Singh et al., 2000) and/or due to impairment of the endogenous processing of the perceived information in major depressive disorder. These possibilities have been confirmed in our study by the clinical findings and psychometric assessment through Mini Mental State Examination scale total scores which were lower in depressive patients than that in controls ($t=5.91$, $p<0.001$). Other findings for the P300 potential have been less consistent, some studies were consistent with our results as regard prolongation of P300 latency in depressed population e.g. Burder et al. (1991) and Singh et al. (2000), while others like Brown et al. (1982) and Sara et al. (1994) failed to find significant prolongation of P300 latency in depressed patients as compared to normal controls although the depressives performed the experimental task significantly less accurately than normal controls. About half of the studies found a reduction of P300 amplitude in depressed individuals and other half finding no difference from normal control participants (Roth et al., 1986). Such discrepancies in findings may be due to multiple factors like age, task difficulty or examinations of different diagnostic subcategories of depression like depressive episode, recurrent depressive disorder and bipolar affective disorder-current episode depression.

It has been proposed that some depressive syndromes may result from disruptions of the cortico-striato-pallido-thalamo-cortical pathways or their connections to monoaminergic centers (George et al., 1994 and Krishnan et al., 1997). In addition, several brain regions are active at the time of scalp recorded P300 e.g. the hippocampus and adjacent areas of limbic system (Halgren, 1980) as well as mistal-temporal areas, parieto-occipital cortex, frontal lobes and dorsal thalamic nuclei (Pineda and Westerfield, 1993). Positron emission tomography (PET) scan studies have reported global or local reductions in cerebral blood flow and metabolism in depression (Baxter et al., 1985). A speculation may be that patients with major depressive disorders has a sort of impairment of the cortico-striato-pallido-thalamo-cortical pathways resulting in depressive syndromes associated with prolonged P300 latency, lowered P300 amplitude and deficits in cognitive functions as shown in our research. On the other hand, depressives in other researches who showed controversial results may had dysregulation and/or lesions in other brain regions.

Earlier ERP components (N100, N200) were also examined to explore the stage of information processing responsible for alterations of cognitive functions in depression. In our study, there was a statistical significant difference of N100 amplitude reduction between depressive group and control group ($t=8.39$, $P<0.001$). This finding agrees with several studies like El-Massioui & Leservre (1988), Yee et al. (1992) and Burkhart & Thomas (1993) and indicates that early sensory/attentional processing of complex tones is impaired in depressed patients. This disagrees with Burder et al. (1995, 1998) who found no difference of N100 amplitude reduction between depressed participants and normal control participants. He concluded that the early sensory/attentional processing of complex tones is intact in moderately depressed outpatients while other studies with controversial results may be specific to severe depression or a subtype of depressive illness. For instance, Shagass (1981) found reductions of this early ERP component to be more evident in psychotic than neurotic individuals.

In our research, the depressed participants did show greater N200 amplitude when compared with normal control participants ($t=-5.49$, $P<0.001$). This finding is in accord with researches finding enhanced N200 in depressed or dysthymic individuals and "at-risk" participants with high physical anhedonia scores (Miller, 1986; Sandman et al., 1992; Giese-Davis et al., 1993; Sara et al., 1994; Bruder et al., 1998). In a trial to explain the enhanced N200 among depressed participants Bruder et al. (1998) concluded that depressed individuals allocate more cognitive resources than would normally be necessary to perform a simple oddball task. The depressed participants in his study and the dysthymic and anhedonic participants in the study by Giese-Davis et al. (1993) showed an enhancement of N200 in the absence of a difference in P300 amplitude. This is consistent with the suggestion that N200 and P300 provide independent sources of information (Miller, 1986).

Conclusions:

ERPs may be useful objective clinical adjunct to behavioral measures of cognitive processes. It is, however, important to control for behavioral function since patients with altered cognition including inattention may not perform the task accurately as well as one needs to be aware of the wide range of variability amongst normal individuals of the ERPs. However, this study is preliminary exploration of the relationship between impairment of the cortico-striato-pallido-thalamocortical pathways and pathophysiology of major depressive disorder using psychometric and electrophysiological measures. Further research may be needed with brain imaging studies of the prefrontal area and basal ganglia as well as tests of specific prefrontal functions.

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REFERENCES:

- American Psychiatric Association (1994): Diagnostic and Statistical Manual of Mental Disorders, 4th ed (DSM-IV), Washington D.C.
- Baxter, J; Phelps, M; Mazziota, J; Schwartz, J; et al. (1985): Cerebral metabolic rates for glucose in mood disorders. Studies with positron emission tomography and fluorodeoxyglucose F18. Arch Gen Psychiatry, 42:441-447.

- Blackwood, D; Whalley, L; Christie, J; Blackburn, I; et al. (1987): Changes in auditory P3 event-related potential in schizophrenia and depression. Br J Psychiat, 150:154-160.
- Bleuler, E (1972): Lehrbuch der Psychiatrie, 12th edn. Springer, Berlin Heidelberg New York.
- Brown, W; March, J and LaRue, A (1982): ERPs in psychiatry: differentiating depression and dementia in the elderly. Bull Los Angeles Neurol Society, 47:91-107.
- Burder, G; Towey, J; Stewart, J; Friedman, D; Tenke, C and Quitkin, F (1991): Event-related potentials in depression: influence of task, stimulus hemifield and clinical features on P3 latency. Biol Psychiat, 30:223-246.
- Burder, G; Tenke, C; Stewart, J; Towey, J; Leite, P and Voglmaier, M (1995): Brain event-related potentials to complex tones in depressed patients: relation of reduced P300 asymmetry to physical anhedonia. Psychophysiology, 35(1):54-63.
- Burder, G; Tenke, C; Towey, J; Leite, P; et al. (1998): Brain ERPs of depressed patients to complex tones in an oddball task: relations to perceptual asymm s. Psychophysiology, 32:373-381. M. SAAD, et al.
- Burkhart, M and Thomas, D (1993): Event-related potential measures of attention in moderately depressed subjects. Electroencephal & Clin Neurophysiol, 88:42-50.
- Diner, B; Holcomb, J and Dykman, R (1985): P300 in major depressive disorder. Psychiatry Res, 15:174-184.
- El-Massioui, F and Leservre, N (1988): Attention impairment and psychomotor retardation in depressed patients: an event-related potential study. Electroencephalogr Clin Neurophysiol 70(1):46-55.
- Engel, R and DeRubeis, R (1993): The role of cognition in depression. In Dobson, K.S., Kandall, P.C. (eds): Psychopathology and Cognition. San Diego, CA: Academic Press, 83-119.
- Folstein, M; Folstein, S and McHugh, P (1975): Minimental state examination: a practical method for grading the cognitive state. J Psychiat Res, 12:189-198.
- Gangadhar, B; Ancy, J; Janakiramaiah, N and Umapathy, C (1993): P300 amplitude in non-bipolar, melancholic depression. J Affect Disord, 28(1):57-60.
- George, M; Ketter, T and Post, R (1994): Prefrontal cortex dysfunction in clinical depression. Depression, 2:59-72.
- Giese-Davis, J; Miller, G and Knight, R (1993): Memory template comparison processes in anhedonia and dysthymia. Psychophysiology, 30(6):646-656.
- Goodin, D; Desmedt, J; Maurer, K and Nuwer, M (1994): IFCN recommended standards for long-latency auditory event-related potentials: Report of an IFCN Committee. Electroencephal Clin Neurophysiol, 91:18-20.
- Halgren, E; Squires, N; Wilson, CL; Rohrbaugh, J; et al. (1980): Endogenous potentials generated in the human hippocampal formation and amygdala by infrequency events. Science, 210:803-805.
- Hansenne, M; Pitchot, W; Pinto, E; et al. (2000): P300 event-related potential and personality in depression. Eur Psychiatry, 15(6):370-377.
- Himani, A; Tandon, O and Bhatia, M (1999): A study of P300 event-related evoked potential in the patients of major depression. Indian J Physiol Pharmacol, 43(3):367-372.
- Kraepelin, E. (1927): "Psychiatrie" 9th Ed. Barth, Leipzig.
- Krishnan, K; Hays, J and Blazer, D (1997): MRI-defined vascular depression. Am J Psychiatry, 497-501.
- Miller, G (1986): Information processing deficits in anhedonia and perceptual aberration: A psychophysiological analysis. Biological Psychiatry, 21:100-115.
- Picton, T (1992): The P300 wave of the human event-related potential. J Clin Neurobiol, 9:456-479.
- Pineda, J and Westerfield, M (1993): Monkey P300 in an "oddball" paradigm pharmacological support for multiple neural sources. Brain Res Bull, 31:689-696.
- Raskin, A; Schulterbrandt, J; Reatig, N and McKeon J (1969): Raskin depression Rating Scale. Sajatovic, In Rating scale in mental health (Eds.) M & Ramirez, LF (2001), pp 96-97. Hudson, OH: Lexi-Comp.
- Roth, W; Pfefferbaum, A; Kelly, A; Berger, P and Kopell, B (1981): Auditory event-related potentials in schizophrenia and depression. Psychiatry research, 4:199-212.
- Roth, W; Duncan, C; Pfefferbaum, A and Timsit-Berthier, M (1986): Application of cognitive ERPs in psychiatric patients, In WC Mc Callum; R Zappoli and F Denoth (Eds.), pp 419-438. Amsterdam:Elsevier
- Sandman, C; Vigor-Zierk, C; Isenhart, R; Wu, J and Zetin, M (1992): Cardiovascular phase relationships to the cortical event-related potential of schizophrenic, depressed and normal subjects. Biological Psychiat, 32:778-789.
- Sara, G; Gordon, E; Kraiuhin, C; Coyle, S; et al. (1994): The P300 ERP component: an index of cognitive dysfunction in depression. J Affect Disord, 31:29-38.
- Shagass, C (1981): Neurophysiological evidence for different types of depression. Jour Behav Ther & Experim Psychiat, 12:99-111.
- Singh, R; Shukla, R; Dalal, P; Sinha, P and Trivedi, J (2000): P300 event-related potential in depression. Ind J Psychiatry, 42(4):402-409.
- Sutton S, Branen M, Zubin J and John E (1965): Evoked potential correlates of stimulus uncertainty. Science, 150:1187-1188.
- Yee, C; Deklin, P and Miller, G (1992): Stimulus intensity effects in dysthymia and anhedonia. J Abnorm Psychol, 101:230-233.

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الملخص العربي

احداثيات الجهد المستنفر في اضطراب الاكتئاب الجسيم : دراسة بقياسات نفسية وفسيولوجية عصبية

أثبتت التقارير السابقة أنه يوجد اختلافات فيما يتعلق بالملامح الإكلينيكية والسيكولوجية والكهروفسيولوجية لدى مرضى اضطراب الاكتئاب الجسيم .

الغرض من هذه الدراسة هو تقدير دلالة العناصر المختلفة للحث الكهربائى للمخ لدى مرضى الاكتئاب العظيم وتقدير مدى ارتباط عناصر الحث الكهربى غير الطبية بالاضطرابات المعرفية وشدة المرض فى اضطراب الاكتئاب الجسيم.

طريقة البحث: أجريت الدراسة على ثلاثين مريضا من الذين يعانون من اضطراب الاكتئاب الجسيم حسب دليل التشخيص و الأحصاء الأمريكى الرابع فى مقابل ثلاثين فردا يمثلون العينة الضابطة لدراسة المتغيرات التالية: البيانات الديموغرافية وشدة الاكتئاب و عطب الوظائف المعرفية وعناصر الحث الكهربى للمخ وتحديد العلاقة بينها.

النتائج: توصلت الدراسة الى النتائج التالية: اظهر المرضى ذوى اضطراب الاكتئاب الجسيم اضطرابا فى تسجيل الحث الكهربى للمخ خاصة تأخير فى الفترة الكامنة لـ P300 وانخفاضا فى مدى موجات P300 & N100 وارتفاعا فى مدى موجة N200 عن أفراد العينة الضابطة ولم ترتبط اضطرابات عناصر الحث الكهربى بشدة الاكتئاب فحسب (باستخدام مقياس راسكن للاكتئاب) ولكنها ارتبطت أيضا بالاضطرابات المعرفية فى الاكتئاب الجسيم (باستخدام مقياس الحالة العقلية المختصر).

الاستنتاج: يستخلص من هذا البحث أن الحث الكهربي للمخ وسيلة نافعة ومفيدة في تقييم الاضطرابات المعرفية وشدة المرض في مرضى الاكتئاب الجسيم والتي بدورها تفسر العلاقة بين اضطراب الدوائر العصبية المسئولة عن النشاط المعرفي والاضطراب الفسيولوجى بالمخ في مرضى الاكتئاب الجسيم.