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INTER- AND INTRA-HEMISPHERIC EEG COHERENCE STUDY IN ADULTS WITH NEUROPSYCHIATRIC DISORDERS

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ABSTRACT

Functional connectivity between different regions of the brain in the resting state has been a recent topic of interest in neurophysiological research. EEG coherence happened to be an useful tool for measuring changes in neuro-psycho-physiological functioning which are not detectable by simply measuring amplitude or power spectra.

The aim of our study was to investigate the changes in the EEG coherence in groups of different mental disorders such as: depression, general anxiety disorder, ADHD, Asperger syndrome and headaches, compared to control group. All measures were made in two conditions: eye opened (EO) and eyes closed (EC).

The obtained results show that in EO condition there is a significantly lower coherence for delta waves between analyzed groups. For theta coherence only for Asperger syndrome we found lower coherence compared to control group, ADHD and headaches in parietal region (P3-P4). Obtained results for intrahemispheric coherence have shown that there was significantly lower coherence in both conditions for delta and theta bands in almost all sites for Asperger's syndrome, and opposite increased intrahemispheric coherence for patients with headaches (for delta band in the anterior regions and for theta band in the posterior regions). ADHD patients expressed lower delta inter-hemispheric coherence in frontal regions, and increased coherence of theta in central regions but increased delta coherence in posterior regions only in EO condition. For depressive and anxiety patients we found decreased intrahemispheric coherence for EO condition for delta brain waves all over the cortex. Concerning the coherence in anxiety patients in our current study we have obtained hypo coherence in centro-parieto-occipital region only for delta in interhemispheric coherence and also lower delta coherence through the cortex for intrahemispheric coherence.

Our findings for interhemispheric hyper coherence in subjects with depression specifically for alpha and beta bands were confirmed in other studies.

We suggest that EEG coherence analysis could be a sensitive parameter in the detection of electrophysiological abnormalities in patients with anxiety, depression, ADHD, Asperger syndrome and headaches. These results can confirm the development of QEEG state and trait biomarkers for psychiatric disorders.

Keywords: QEEG, psychiatric patients, coherence

INTRODUCTION

EEG coherence measures similarities in electrical cortical activity between electrodes sites [1], and has been conceptualised as the correlation in the time domain between two signals in a given frequency band[2]. In this context, EEG coherence represents the consistency of phase difference between two EEG signals (on a frequency by frequency basis) when compared over time and thus yields a measure of synchrony between the two EEG channels and an index of brain connectivity between the brain regions accessed by the chosen electrodes. The presence of coherence in the EEG is one of the signs of interaction and synchronization among the units. Coherence is a measure of how effectively two sites are able to link and unlink, to share information. Whether coherence is a good thing or a bad thing depends to some extent on what frequency we are talking about and what sites and what task. High coherence represents a measure of strong connectivity, and low coherence a measure of weak connectivity. High coherence between two EEG signals has been interpreted as reflecting a strong structural or functional connection between the underlying cortical regions [3]. A recent attempt to relate functional aspects of neural integration to different frequencies proposed that higher frequencies are involved in short-range integration, while lower frequencies are involved with longer-range integration [4].

Functional connectivity between different regions of the brain in the resting state has been a recent topic of interest in neurophysiological research. EEG coherence is a useful tool for measuring changes in neuro-psycho-physiological functioning which are not detectable by simply measuring amplitude or power spectra.

In modern time, using fMRI studies connectivity is established by the correlations in hemodynamic activity over time between different brain regions. An analogous pattern in an EEG study would be correlations in amplitude over time between different scalp locations within particular frequency ranges. Examination of EEG coherence measures may be particularly useful in interpreting the functional aspect of connectivity.

Practically, the coherence is a statistical measure of the average agreement in phase difference, weighted by amplitude, between two signals measured over time, and is frequency specific. Patterns of resting-state activity are important for understanding intrinsic neural function, and may be significant in shaping responses to stimuli. Coherence is not measured in Hertz or microvolts. It is a measure, like the correlation coefficient, which ranges from 0-1 or (in percentage terms) from 0-100. Thus, coherence values range from 0 to 1, with 1 meaning perfect agreement in phase difference, and 0 meaning completely random phase differences. The authoritative introduction to the measurement of the coherence of scalp recorded EEG signals could be found in articles of Nunez et al. [5]; Srinivasan et al. [6], Nunez et al. [7].

A theory of EEG coherence is offered by Robinson[8] based on an analysis of the character of thalamocortical and corticocortical circuits by continuum methods. This theory uses a dispersive model of neural firing patterns; the equation expressing coherence as a function of distance is parameterized by the values of characteristics of individual neural interconnections.

Coherence is a sensitive measure that can reveal subtle aspects of the network dynamics of the brain which complement the data obtained by power spectral analyses. Coherence has been applied to studies of various clinical populations. There is a growing body of evidence suggesting that altered brain connectivity may be a defining feature of disorders such as ADHD, depression, general anxiety disorder, Asperger syndrome and headaches.

From many of the psychiatric disorders, maybe the EEG coherence is the most researched in attention deficit hyperactivity disorder (ADHD). Many studies utilizing EEG coherence have shown significant differences between control and ADHD subjects, as well as differences within the ADHD population and in regard to the degree of response to therapeutic medications [9-14].

EEG coherence studies in patients with depression showed different results. Some studies for patients with depressive disorder reported reduced coherence values compared to healthy controls [15-16]; other studies showed significantly higher overall or partial coherence in patients with major depressive disorder as compared to controls [17-19]. Opposite to those studies, Suhhova et al. [20] demonstrated no sig-

nificant changes in the EEG coherence between healthy subjects and patients with depression.

Concerning the generalized anxiety disorder (GAD), there are few studies that use EEG coherence for determining the parameters useful in differentiation of GAD compared to other disorders. Most of these studies [21-22] consider GAD not as pure disorder, but as a state accompanying the other situations (e.g. watching negative stimuli; impact of social-emotional information on an individual, etc.). Xing et al. [23] found increased oscillatory midline coherence in the theta frequency band indicating higher connectivity in the generalized social anxiety disorder relative to healthy control group during rest.

In the new DSM-5, Asperger syndrome is incorporate into autism spectrum disorders (ASD) with essential equivalence to high functioning autism. The study of Duffy [24] et al. uses EEG coherence as a measure of brain connectivity to explore possible neurophysiological differences between Asperger syndrome and ASD. The same author [25] demonstrated that a stable pattern of EEG spectral coherence factors separated ASD subjects from neurotypical control subjects. Clarke et al. [26] and Coben et al. [27] found reduced EEG coherence in children with Asperger syndrome.

Additionally, headache is another condition in which EEG coherence was investigated. Koeda et al. [28] even in 1999 suggest that EEG coherence analysis is a sensitive parameter in the detection of electrophysiological abnormalities in patients with migraine. The recent study of Cao et al. [29] found that resting-state EEG power density and effective connectivity differ between migraine phases and provide an insight into the complex neurophysiology of migraine.

The aim of our study was to investigate the changes in the EEG coherence in groups of different mental disorders such as: depression, general anxiety disorder, ADHD, Asperger syndrome and headaches compared to control group.

METHOD

All analyses were performed at the Neurophysiology Laboratory of the Macedonian Academy of Sciences and Arts. This laboratory maintains a comprehensive raw EEG database of 300 patients and volunteers with neurotypical development. In addition to referral information, patients are typically referred from clinicians to confirm or rule out abnormalities by EEG and cognitive evoked potentials.

2.1. Participants

We evaluated coherence of QEEG records in patients with general anxiety disorder (N=7, 4F+3M; mean age = 32y ± 7.46), depression (N=5, 1F+4M; mean age = 43.8y ± 16.17), ADHD (N=10, 10M; mean age = 40y ± 6.36), tension type headaches (N=3, 2F+1M; mean age = 37.6y ± 2.52), Asperger syndrome (N=5, 3F+2M; mean age = 17.75y ± 5.05) and control (neurotypical) individuals (N=10, 10M; mean age = 25.1y ± SD 6.84).

All selected patients were diagnosed using ICD-10 criteria. Additional psychometric tests were applied, but only EEG data are utilized and reported in this study.

None of the subjects had any serious medical or neurological problems (including seizures) or recent (<6 months) head trauma. Finally, if any participant displayed spike wave EEG activity, he was excluded from the study. Washout period of 48 hours was applied for the patients taking psychotropic medications.

Only right-handed subject were included in the study. All participants gave informed, written consent and the study was approved by the local ethics committee. The subjects did not receive any compensation for their participation in this study. Control participants also had to score below the clinical levels on the symptom checklists, and not reported any problems at the clinical interview which could be indicative of psychopathology.

2.2. EEG recording

EEG was recorded using a Mitsar 201 (www.mitsar-medical.com), a PC-controlled 19-channel electroencephalographic system. During fitting of the electrodes, subjects were familiarized with the testing equipment and the procedure. While seated in a comfortable chair, subjects were required to fixate on a computer monitor for a 5 minute period while EEG was recorded with eyes-open condition, and then 5 minutes of eyes closed condition. All participants were instructed to avoid excessive blinking.

EEG recordings were obtained using an electrode cap (Electro-Cap International) with

19 electrodes placed according to the international 10-20 system, linked ear lobe (A1-A2) referenced and electrode impedance maintained below 5 Kohms for all electrodes. The input signals were filtered between 0.5 and 30 Hz, and digitized at a sampling rate of 256 Hz. Vertical electro-oculogram (VEOG) was recorded with 2 tin electrodes placed 1 cm above and 1 cm below the right eye. The cap ground electrode was midway between Fpz and Fz. Quantitative data were obtained using WinEEG software (www.mitsar-medical.com). The linked ears reference montage was changed to average montage prior to data processing. The average montage was used because it allowed comparisons with the HBI database in WinEEG software. Eye-blink artifacts were corrected by zeroing the activation curves of individual ICA component score responding to eye blinks. In addition, epochs of the filtered electroencephalogram with excessive amplitude (>100 μV) and/or excessively fast (>35 μV in 20-35 Hz band) and slow (>50 μV in 0-1 Hz band) frequency activities were automatically marked and excluded from further analysis. Finally, EEG was manually inspected to verify artifact removal. A minimum of 90 s of artifact-free EEG was available for analysis, from which 4 s epochs were analyzed.

2.3. Coherence analysis

Coherence analysis was carried out for the four frequency bands: delta (0.5-4 Hz), theta (4-8 Hz), alpha (8-13 Hz), and beta (13-21 Hz). We used these classic fixed frequency ranges to allow our data to be compared to existing coherence data which has used the stated ranges.

Coherence between an electrode pair for a particular frequency band was defined at the cross-spectral power between the sites normalised by dividing by the square root of the product of the power at each site within that band. Coherence estimates were derived for each band for 12 intrahemispheric (F3-O1, F3-P3, F3-C3, C3-P3, O1-C3, O1-P3, F4-O2, F4-P4, F4-C4, C4-P4, O2-C4, O2-P4) and four interhemispheric (F3-F4, C3-C4, P3-P4, O1-O2) electrode pairs.

The WinEEG software allows the mapped computation of ‘average coherence’ across a range of frequencies across the brain, and gives us a window onto ‘integration’ of function in that range. The EEG coherence is presented by so called interaction diagrams. Coherence is expressed in numbers from 0-1, zero being absolutely no relatedness between the signals. High coherence represents a measure of strong connectivity, and low coherence a measure of weak connectivity.

In the WinEEG software program for EEG coherence, electrodes are connected by curves with different thickness and colors in dependence of value of average coherence: dark blue line - 0.20; turquoise - 0.40; pink - 0.60; red - 0.80.

2.4. Data analysis

Statistics was calculated using Statistica package 10. Analysis of variance (ANOVA) was performed with two factors: `brain state’ (eyes open and eyes closed), `hemisphere’ (left and right), and six dependent variables which were defined by INTRA-hemispheric coherence values: F-O (fronto-occipital), F-C (fronto-central), F-P (fronto-parietal), C-P (centro-parietal), O-P (occipito-parietal), and OC (occipito-central). Along with this, a one-way ANOVA was performed: `brain state’ and `INTER-hemispheric coherence’. Greenhouse-Geisser correction was applied in the ANOVAs, and the Bonferroni posthoc test was used where appropriate.

RESULTS

3.1. Interhemispheric coherences

3.1.1. Eyes opened

Diagrams of EEG coherence in EO condition in different patient’s group are displayed on Fig. 1, 2, 3 and 4.

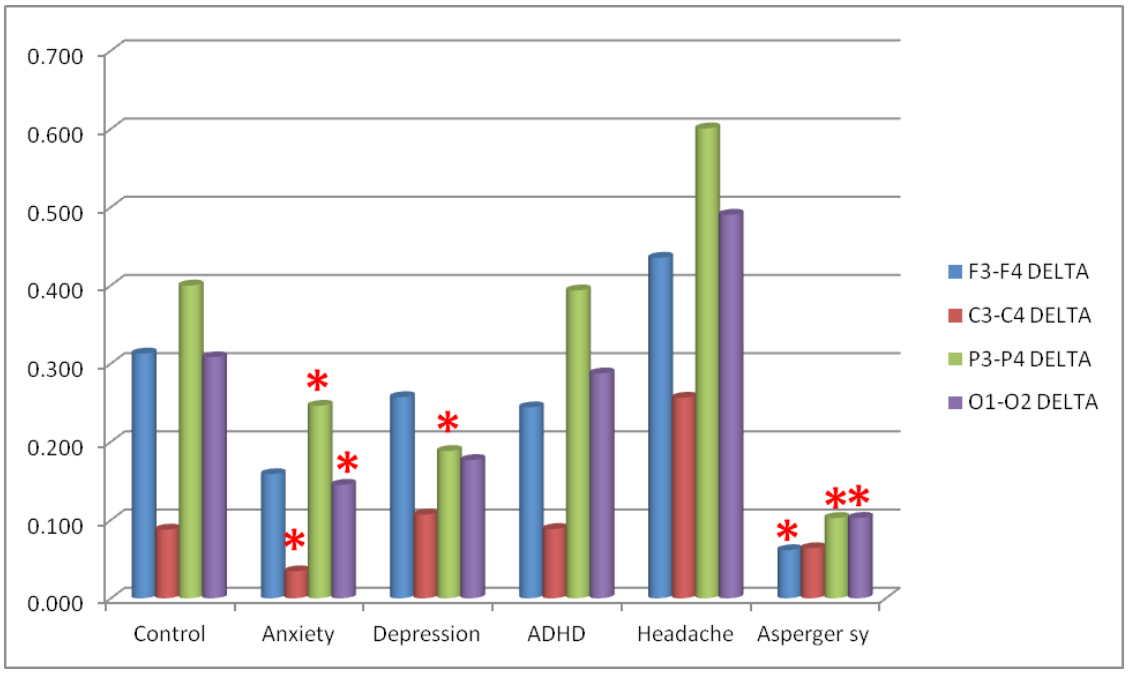


Fig. 1. *Interhemispheric coherence for Delta waves in eyes-opened condition*

For delta coherence the obtained results showed that there were significant coherence differences between analyzed groups with $F(20, 100)=2.36$, ($p<0.01$). In Asperger syndrome we obtained significantly lower delta interhemispheric coherence compared to headaches ($p<0.01$) for F3-F4 and anxiety compared to headaches for C3-C4 ($p<0.05$). In P3-P4 positions the interhemispheric coherence was significantly lower for Asperger patients compared to control group ($p<0.01$), ADHD ($p<0.01$) and headaches ($p<0.01$). Also, the anxiety and depressive patients had lower delta coherence in P3-P4 compared to patients with headaches ($p<0.01$). For O1-O2 there was greater delta coherence for headaches patients compared to anxiety ($p<0.05$) and Asperger patients ($p<0.05$).

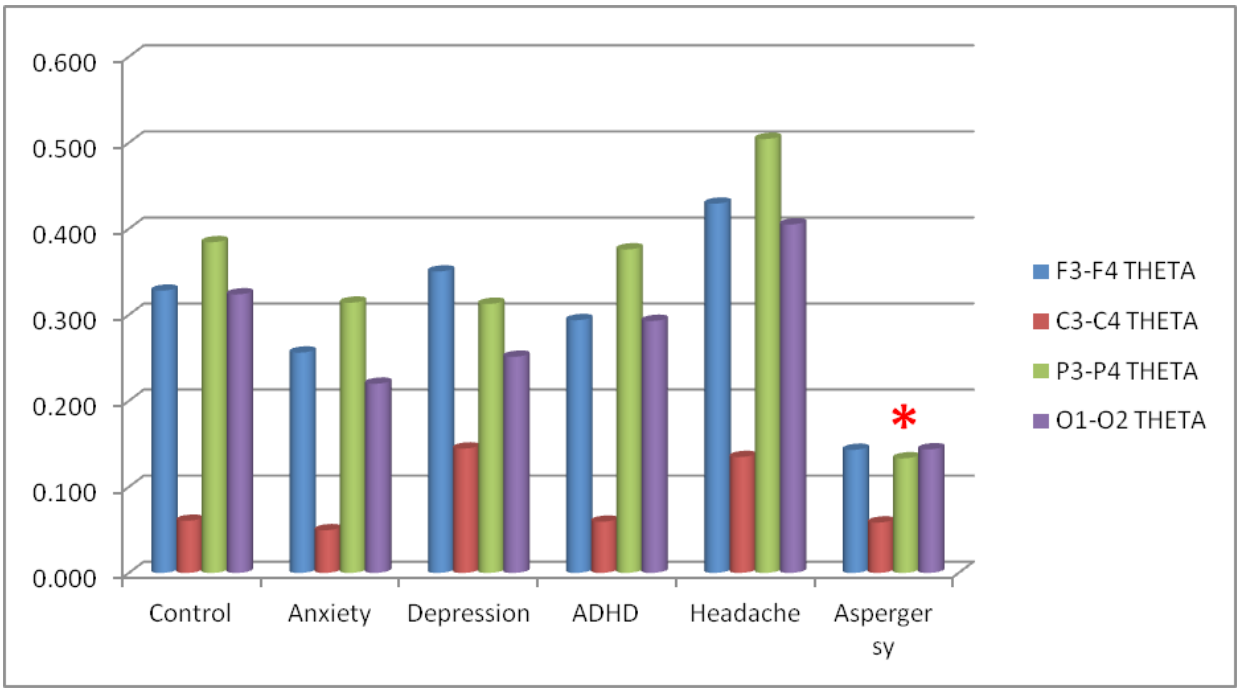


Fig. 2. *Interhemispheric coherence for Theta waves in eyes-opened condition*

For theta coherence the obtained results showed that only in Asperger syndrome there was lower coherence compared to control group ($p<0.05$), ADHD ($p<0.05$) and headaches ($p<0.01$) for P3-P4.

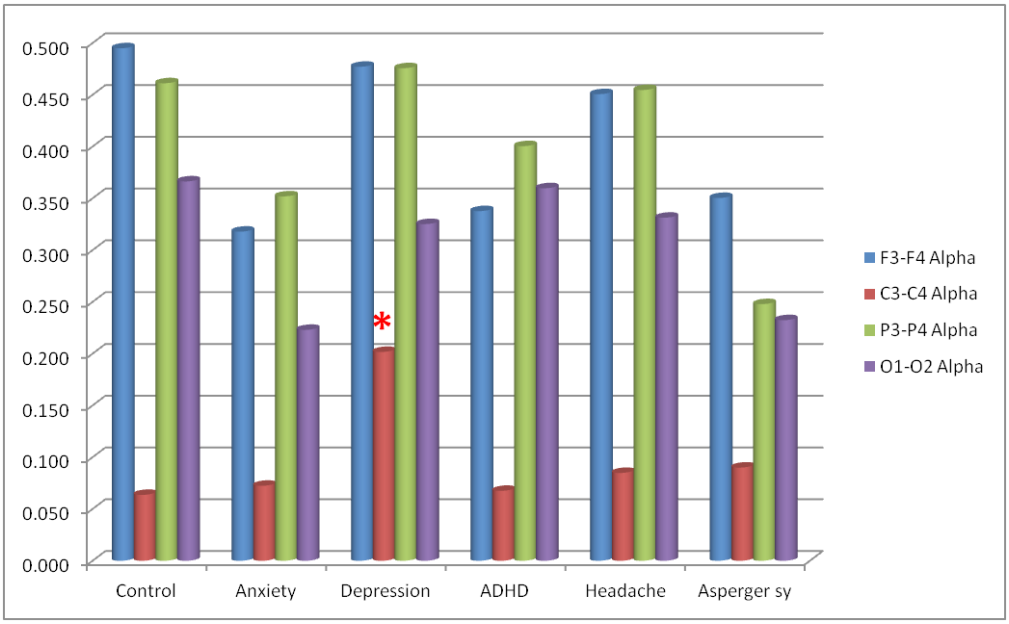


Fig. 3. *Interhemispheric coherence for Alpha waves in eyes-opened condition*

Depressive patients showed significantly greater interhemispheric alpha coherence only in C3-C4 compared to control group ($p<0.01$), anxiety ($p<0.05$) and ADHD ($p<0.01$) patients.

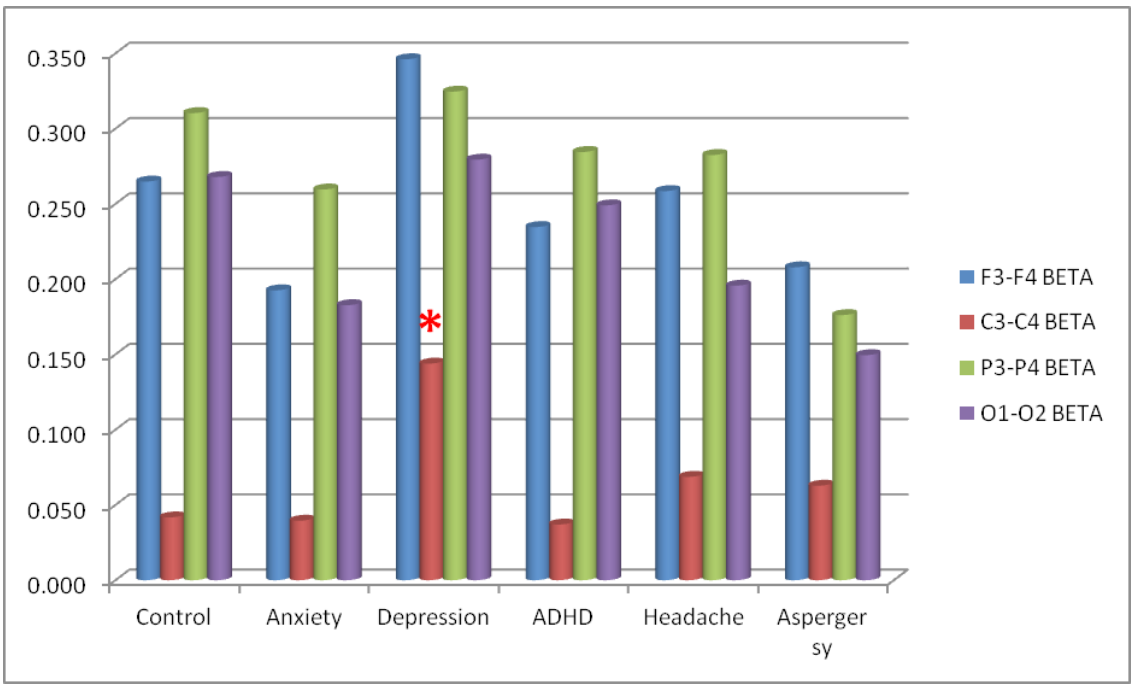


Fig. 4. *Interhemispheric coherence for Beta waves in eyes-opened condition*

Depressive patients showed significantly greater interhemispheric beta coherence only in C3-C4 compared to control group ($p<0.05$), anxiety ($p<0.05$) and ADHD ($p<0.01$).

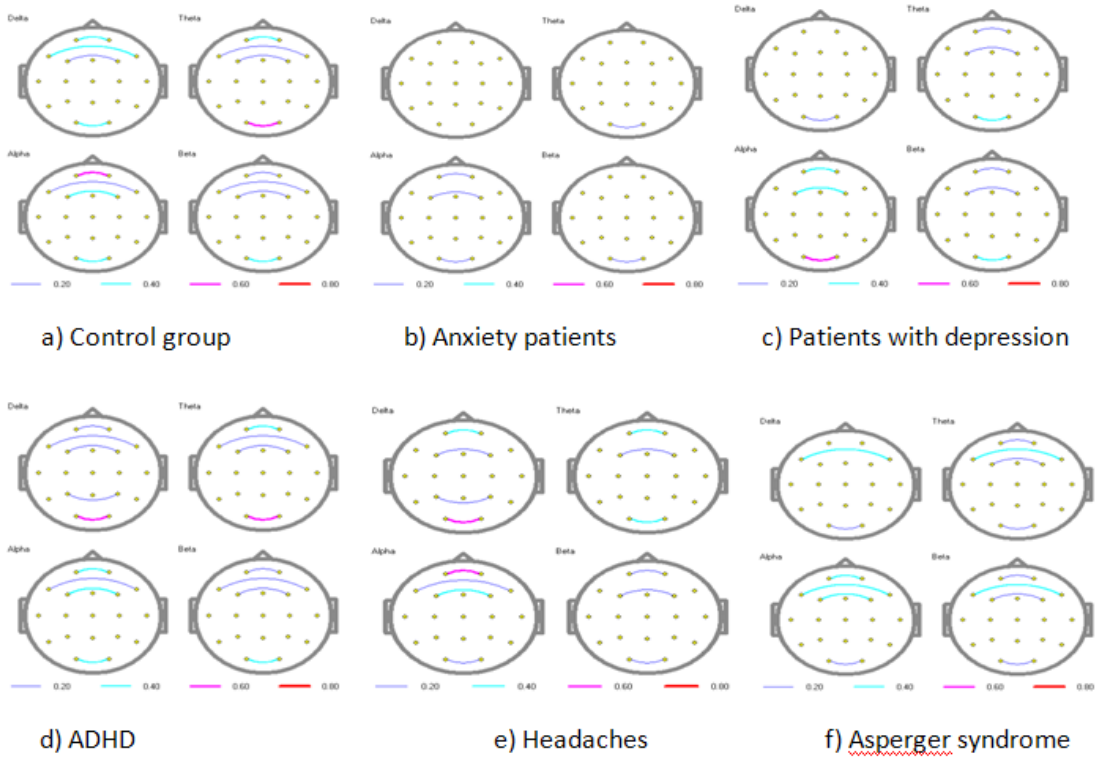


Fig. 5. *Brain maps of interhemispheric coherence for eyes-opened condition for all groups*

3.1.1. Eyes closed

Diagrams of EEG coherence in EC condition in different patient's group are displayed on Fig. 6, 7, 8, and 9.

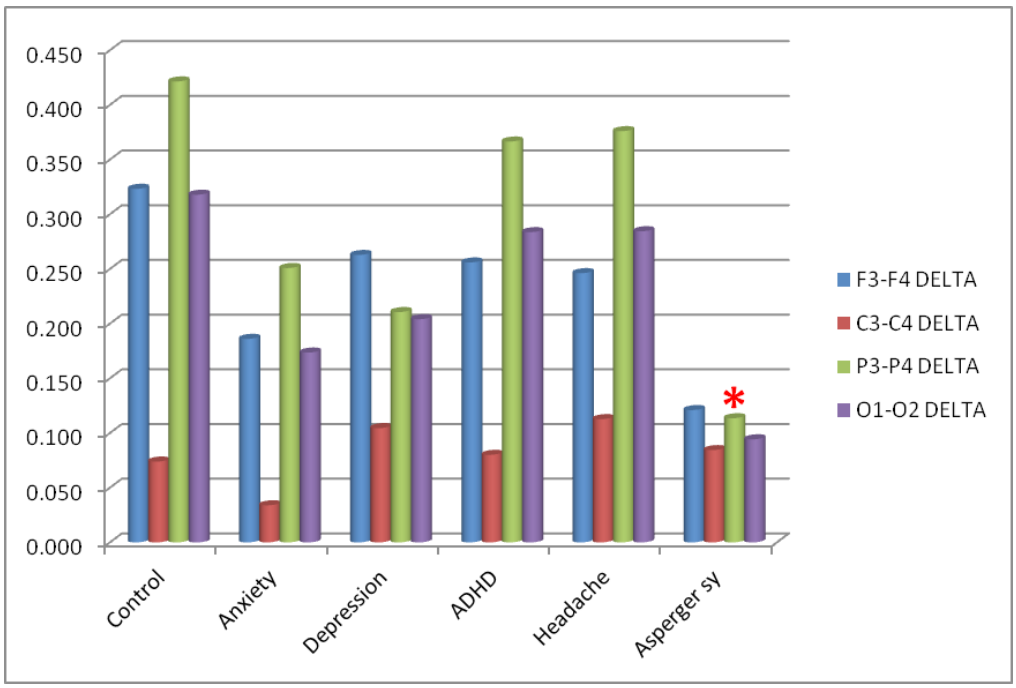


Fig. 6. *Interhemispheric coherence for Delta waves in eyes-closed condition*

Patients with Asperger syndrome showed significantly lower interhemispheric delta coherence only in P3-P4 compared to control group (p=0.00), and ADHD (p=0.03).

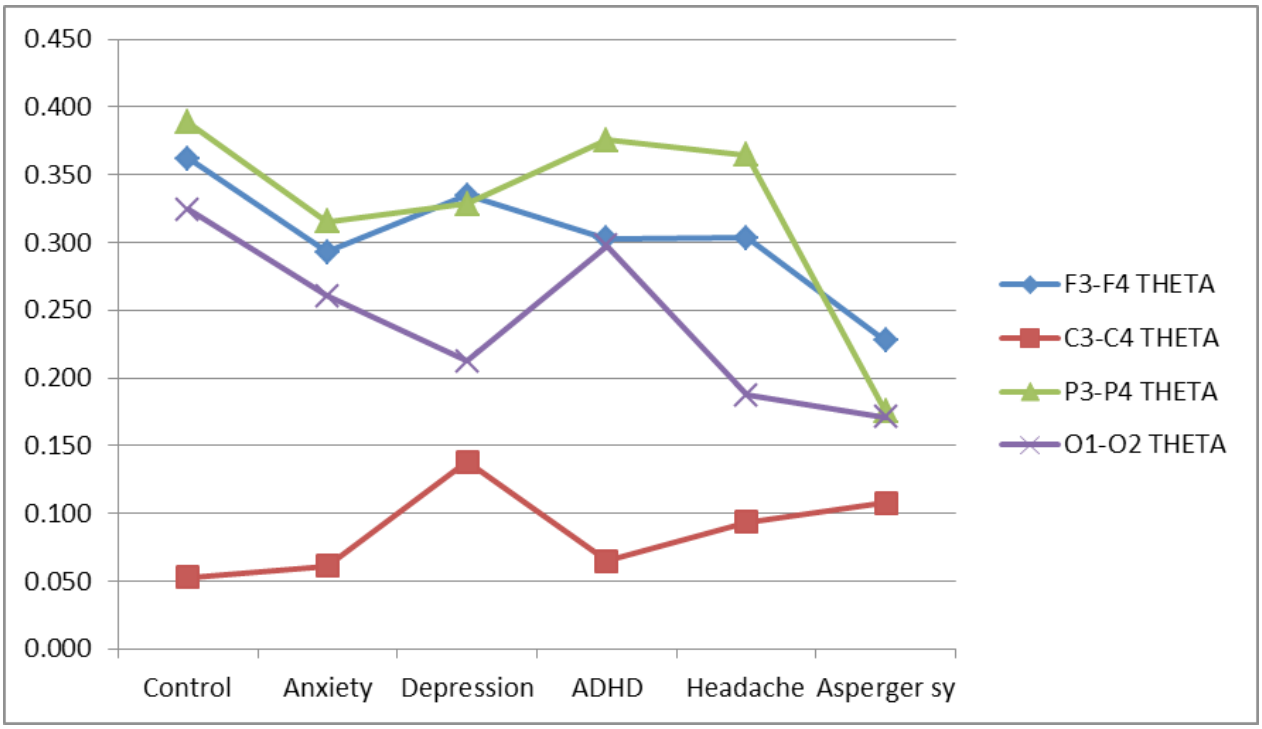


Fig. 7. *Interhemispheric coherence for Theta waves in eyes-closed condition*

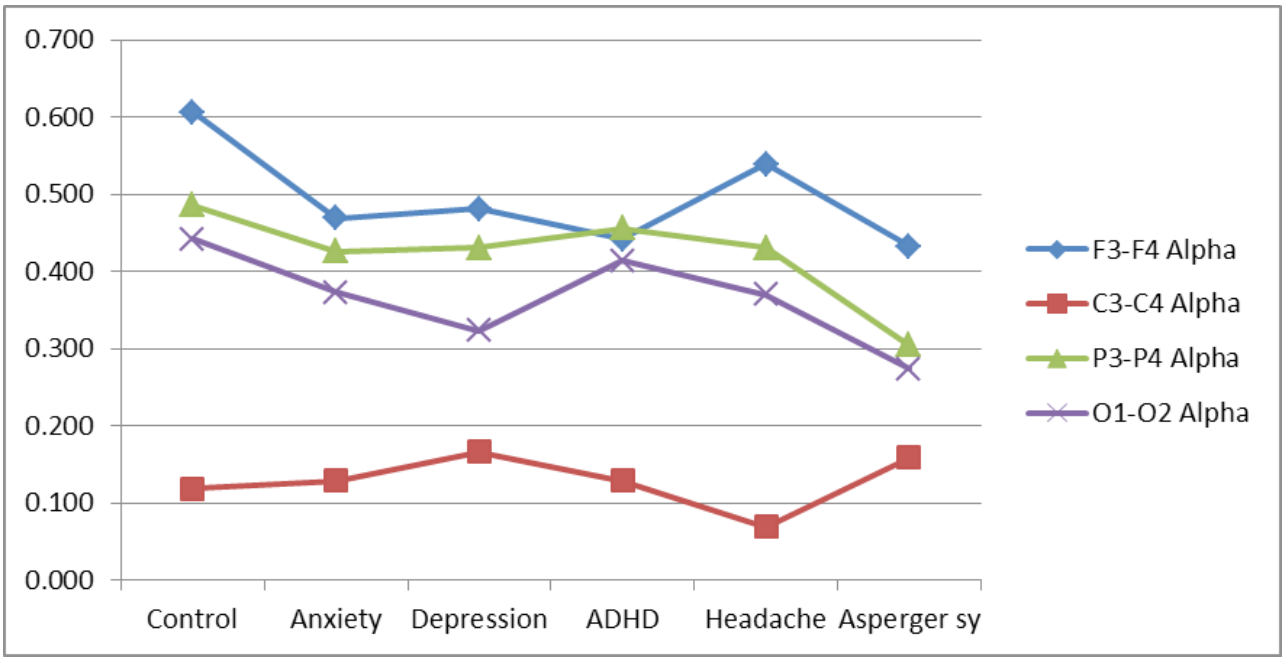


Fig. 7. *Interhemispheric coherence for Alpha waves in eyes-closed condition*

In eyes closed condition we did not obtain any significant interhemispheric difference for theta and alpha between groups.

Depressive patients showed significantly higher interhemispheric beta coherence only in C3-C4 compared to control group ($p<0.01$), and ADHD ($p<0.05$).

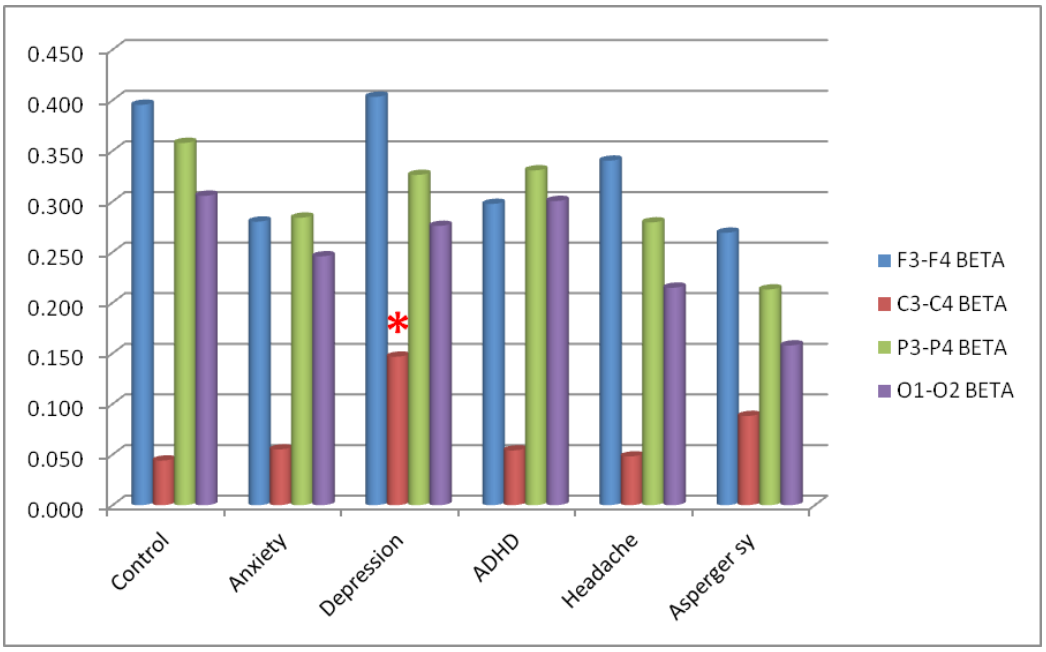


Fig.9 . *Interhemispheric coherence for Beta waves in eyes-closed condition*

3.2. Intrahemispheric Coherence

The significant differences with $p<0.05$ between patients for intrahemispheric coherence values for each brain state are presented in Table 1.

Table 1. *Significant differences with p<0.05 between patients for intrahemispheric coherence values for each brain state*

	Control group	Anxiety patients	Depressive patients	ADHD	Patients with headache	Asperger syndrome
F3-O1						
Eyes open		Delta ▼			Delta ▲	Delta ▼
Eyes closed	Delta ▲					Delta ▼
F3-P3						
Eyes open		Delta ▼	Delta ▼	Delta ▼	Delta ▲/ Theta▲	Delta ▼/ Theta▼
Eyes closed	Delta ▲					Delta ▼
F3-C3						
Eyes open					Delta ▲/ Theta▲	Delta ▼/ Theta▼
Eyes closed						
C3-P3						
Eyes open		Delta ▼	Delta ▼		Delta ▲	Delta ▼
Eyes closed	Delta ▲					Delta ▼
O1-C3						
Eyes open					Delta ▲	Delta ▼
Eyes closed						
O1-P3						
Eyes open		Delta ▼	Delta ▼		Delta ▲	Delta ▼

Eyes closed	Delta ▲					Delta ▼
F4-O2						
Eyes open					Delta ▲	Delta ▼
Eyes closed						
F4-P4						
Eyes open					Delta ▲	Delta ▼
Eyes closed						
F4-C4						
Eyes open						
Eyes closed						
C4-P4						
Eyes open	Theta▲	Delta ▼	Delta ▼	Theta▲	Delta ▲/ Theta▲	Delta ▼/ Theta▼
Eyes closed	Delta ▲					Delta ▼
O2-C4						
Eyes open		Delta ▼	Delta ▼		Delta ▲/ Theta▲	Delta ▼/ Theta▼
Eyes closed	Delta ▲	Delta ▼				
O2-P4						
Eyes open	Delta ▲/ Theta▲	Delta ▼	Delta ▼	Delta ▲	Delta ▲/ Theta▲	Delta ▼/ Theta▼
Eyes closed	Delta ▲/				Delta ▲/	Delta ▼

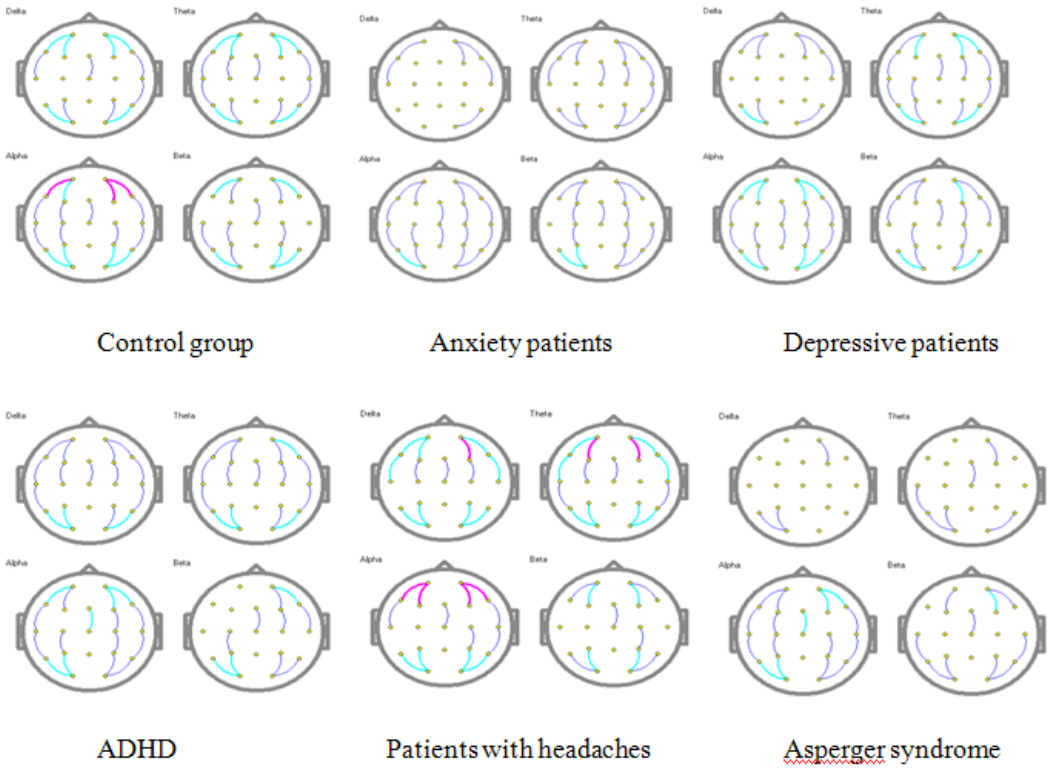


Fig. 10. *Brain maps of intrahemispheric coherence in eyes opened condition for all groups*

DISCUSSION

The goal of this study was to explore the EEG coherence relationship between a sample of subjects clinically defined as having anxiety, depression, ASP, ADHD and headaches, and a population of previously well-studied neurotypical controls. The EEG coherence as dependent variable of interest, was derived from systematically de-artifacted EEG data for four frequency bands in EO and EC conditions.

The obtained results showed that in EO condition there was a significantly lower coherence for delta waves between analyzed groups. Except patients with headaches who had higher interhemispheric coherence at all sites, all other groups especially ASP, anxiety and depression group had lower interhemispheric coherence for delta band. Additionally, ASP group in EC condition showed lower interhemispheric coherence in parietal region compared to control group and ADHD.

For theta coherence only for Asperger syndrome we found lower coherence compared to control group, ADHD and headaches in parietal region (P3-P4). We did not obtain any significant interhemispheric difference for theta and alpha between groups. Depressive patients showed significantly greater interhemispheric alpha and beta coherence especially at central sites compared to control group, anxiety and ADHD.

Our results for intrahemispheric coherence have shown that there was significantly lower coherence in both conditions for delta and theta bands in almost all sites for Asperger syndrome patients, and opposite increased intrahemispheric coherence for patients with headaches for delta band in the anterior regions and for theta band in the posterior regions. ADHD patients expressed lower delta interhemispheric coherence in frontal regions, and increased coherence of theta in central regions and increased delta coherence in posterior regions only in EO condition. For depressive and anxiety patients we found decreased intrahemispheric coherence for EO condition for delta brain waves all over the cortex.

While doing this study we realized that there were very few papers concerned with EEG coherence in adults. Our results obtained for ASP were in line with the findings of Coben et al.27 who found low interhemispheric delta and theta coherences across the frontal region; delta, theta and alpha hypo coherence was also evident over the temporal regions and there were low delta, theta and beta coherence measurements across posterior regions. He suggested that this dysfunctional integration of frontal and posterior brain regions in autistics was along with a pattern of neural under connectivity. Similar results were reported 8 years later by Clarke et al.26 and in this study subjects with Asperger syndrome exhibited a broad pattern of reduced hemispheric asymmetry in intrahemispheric coherence. They also found reduced anterior interhemispheric coherence in the alpha and beta bands in the Asperger syndrome group. Saunders et al. (2016) [30] also revealed decreased coherence in the frontal lobe networks in those with ASD compared to neurotypical controls. This is consistent with other EEG spectra and fMRI research suggesting that neural connectivity anomalies are a major deficit leading to autistic symptomatology. Reduced anterior interhemispheric coherence in the alpha and beta bands was also found in the Asperger syndrome group. These results suggest the existence of frontal lobe abnormalities in children with Asperger syndrome, and possible abnormalities in normal CNS maturational processes. When the coherence stays locked in during a task, it suggests that the neurons are not able to shift into productive states. Low coherence in slow frequencies suggests an irritated, excited brain, one which does not communicate well within itself, wastes a lot of energy, and an engine that doesn't know how to idle (www.brain-trainer.com) [31].

Our interhemispheric hyper-coherence findings in subjects with depression specifically for alpha and beta bands, are in line with the findings of Leuchter et al. [17] who claimed that patients with depression had significantly higher overall coherence as compared to controls in delta, theta, alpha, and beta frequency bands. The overall greater coherence observed in depressed subjects establishes a new context for the interpretation of previous studies showing differences in frontal alpha power and synchrony between subjects with depression and normal controls. Coherence analysis showed that it is possible to discriminate mainly between interhemispheric locations than intra-hemispheric. That is similar to our results, in which intrahemispheric coherence was lower for delta band in depressive patients. Also, Li et al. [18] stated that decrease in delta in major depression indicated impairment of the connection between the frontal and parietal/

temporal/occipital regions. He explained that the increase in theta, alpha and beta in the frontal/prefrontal sites might reflect the compensatory mechanism to maintain normal cognitive performance. These findings may provide a foundation for a new approach to evaluate the effectiveness of therapeutic strategies for depression. Contrary to these results, the experiments of Suhhova et al. [20] demonstrated no significant changes in the EEG coherence between healthy subjects and patients with depression or reduced coherence values compared to healthy control in alpha, theta and beta rhythms.

Concerning the coherence in anxiety patients in our current study we have obtained hypo-coherence in centro-parieto-occipital region only for delta in interhemispheric coherence and also lower delta coherence through the cortex for intrahemispheric coherence. Theta-dependent interconnectivity was associated with state anxiety in general social anxiety disorders according to Xing et al. [23] However, we did not find that kind of results. The study of Putman et al. (2011) [21] found that delta-beta coherence may reflect emotion regulation processes and supports suggestions that δ-β coherence may be a useful tool in the study of affect and psychopathology. In addition, results showed an unexpected negative association between δ-β coherence and self-reported trait anxiety. Still, the research knowledge in this field is very scarce.

The most investigated coherence is in the ADHD field. There are many studies about coherence in ADHD, especially in children and from Barry and Clarke Australian research group. Barry & Clarke et al. [12-13] found that at shorter inter-electrode distances, ADHD children had elevated intrahemispheric coherences in the theta band and reduced lateral differences in the theta and alpha bands. At longer inter-electrode distances, ADHD children had lower intrahemispheric alpha coherences than controls. Frontally, ADHD children had interhemispheric coherences elevated in the delta and theta bands, and reduced in the alpha band. An alpha coherence reduction in temporal regions, and a theta coherence enhancement in central/parietal/occipital regions, were also apparent. EEG coherences suggest reduced cortical differentiation and specialisation in ADHD, particularly in cortico-cortical circuits involving theta activity. Generally, ADHDcom children displayed greater anomalies than ADHDin children. About ADHD we have got relatively normal interhemispheric coherence for ADHD compared to controls and other groups. Frontal delta intrahemispheric hypo-coherence and central theta hyper coherence was obtained for our ADHD adult patients. A laterality effect was found by Clarke et al. [14] for intrahemispheric coherence in ADHD adults at long inter-electrode distances, with the ADHD group showing reduced hemispheric differences in the delta band compared to the control group. In the alpha band, at short-medium inter-electrode distances, the ADHD group had also lower coherences than the control group. The results suggest that theta coherence differences reported in children with ADHD may be associated with hyperactivity, which is reduced in adults with ADHD, while reduced alpha coherence could be associated with inattention, which remains in adult with ADHD. Reduced delta coherence also appears to be an aspect of the disorder which may develop from later childhood into adolescence and adulthood.

Twenty women with migraine were evaluated for EEG coherence analysis by Koeda et al. [28] In comparison with controls, the subjects with migraines showed lower inter-hemispheric coherence values at C3-C4 for the delta band and at F3-F4 and C3-C4 for the beta band frequency. In contrast [22], intrahemispheric coherence pairs were significantly higher in the migraine group than in the control group. Our results are very similar to those results. Cao et al. [29] even found that resting-state EEG power density and effective connectivity differ between migraine phases and provide an insight into the complex neurophysiology of migraine.

Most of the studies with coherence are done within EC condition. So, the advantage of our study is that we analyzed coherence in EO condition and compared two conditions among few patients groups. Most significant and interesting data we found for EO condition compared to EC condition.

Limitations. There are limitations in the current study that are worth mentioning. The first limitation was our small sample size. A larger-scale study investigating the pure groups to their comorbid counterparts would provide additional valuable information. While participants were asked not to take their medication two days before participation to minimize the impact on EEG recording, it is possible that participants' performance was still affected. Combination or

clustering of channels or blind source separation methods also could lead to a more specific pattern.

CONCLUSION

We suggest that EEG coherence analysis could be a sensitive parameter in the detection of electrophysiological abnormalities in patients with anxiety, depression, ADHD, Asperger syndrome and headaches. These results can confirm the development of QEEG state and trait biomarkers for psychiatric disorders. We hope that in the future with the help of coherence results we can be able to verify evidence of normal or abnormal network activity in psychiatric patients.

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Declaration of Conflicting Interests

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Резиме

СТУДИЈА ЗА ИНТЕР- И ИНТРАХЕМИСФЕРНАТА КОХЕРЕНЦИЈА КАЈ ВОЗРАСНИ СО РАЗНИ ПСИХИЈАТРИСКИ РАСТРОЈСТВА

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Функционалната поврзаност меѓу разни региони на мозокот во состојба на мирување предизвикува посебен истражувачки интерес во невропсихологијата. ЕЕГ-кохеренцијата се покажа како корисна алатка за мерење на промените во неврофизиолошкото функционирање, кои не можат да се детектираат преку едноставното мерење на амплитудите и спектралната моќност.

Целта на ова истражување беше да се истражат промените во ЕЕГ-кохеренцијата кај разни групи ментални растројства, како: депресија, генерална анксиозност, АДХД, Аспергер синдром и главоболки, споредени со контролна група. Сите мерења се правени во две состојби: отворени очи (ЕО) и затворени очи (ЕС).

Добиените резултати покажаа дека во состојбата ЕО постои сигнификантно помала кохеренција за делта-брановите кај испитуваните групи. За тета-кохеренцијата само болните со Аспергер покажаа помала кохеренција споредено со другите групи, особено во париеталниот регион (P3 i P4).

Резултатите за интрахемисферна кохеренција покажаа дека е сигнификантно пониска кохеренцијата во двете состојби за делта- и тета-брановите речиси во сите точки кај Аспергер синдромот и, обратно, зголемена е интерхемисферна кохеренција за пациентите со главоболки (за делта-брановите во предните мозочни региони) и за тета (во задните региони на мозокот, но само при состојба ЕО).

За депресивно болните и оние со анксиозност најдовме намалена интрахемисферна кохеренција во состојбата ЕО за делта-брановите низ целиот кортекс. Анксиозно болните покажаа хипокохеренција во ценро-парието-окципиталната регија само за делта во интерхемисферна кохеренција и, исто така, помала делта-кохеренција низ целиот кортекс за интрахемисферна кохеренција. Најдената хиперкохеренца интерхемисферно кај депресивно болните специјално за алфа- и бета-брановите се потврдува и во други студии.

Сугерираме дека анализата на ЕЕГ-кохеренцијата може да биде чувствителен параметер за откривање на електрофизиолошки абнормалности кај пациентите со анксиозност, депресија, АДХД и Аспергер синдром, како и кај главоболките. Овие резултати го потврдуваат развојот на QEEG состојбите како биомаркери кај психијатриските болни.

Клучни зборови: QEEG, психијатриски болни, кохеренција