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COMPLEX REACTION TIME AND EEG CHARACTERISTICS IN ALCOHOLICS

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In a group of 88 male alcoholics a psychodiagnostic electronic series CRD test (Complex Reactiometer Drenovac) was applied and electroencephalograms (EEG) were recorded. Results showed a relationship between the frequency of the basic rhythm in the EEG finding and rapid, accurate reactions at the CRD 4-A test. A positive relationship was also found between the satisfactory blocking of the basic rhythm by eye opening and faster and more accurate reactions at the same test.

Key terms:
cerebral disorders, male alcoholics, mental ability

The effect of long-term alcohol consumption on the central nervous system has long been the centre of interest for many investigators, including psychologists, neurologists, psychiatrists and physiologists.

The high specificity and differentiality of cerebral functions necessitate an interdisciplinary approach, which includes various diagnostic procedures. Numerous investigators in this field have confirmed a correlation between long-term alcohol consumption and brain damage, i.e. deterioration of intellectual functions (1-11).

The aim of the study was to establish a possible link between electroencephalographic characteristics and the characteristics of complex reaction time in alcoholics. Both methods are indirect indicators of brain function and are widely accepted in diagnostic procedure. The overlapping of "bad" results for both methods cannot be anticipated, as this would mean that they measure or outline the same characteristics. Thus, it is of interest to establish in which qualitatively different modalities certain overlapping can be found.

SUBJECTS

The sample consisted of 88 male alcoholics, aged 50.9±4.9 years (range 38-60), average years of education 5.4±2.6 (range 1-12). All subjects were undergoing the process of work ability evaluation. A diagnosis of alcoholism was verified in accordance with the World Health Organization criteria (DSM-III-R). All alcoholics were in a phase of reduced tolerance to alcohol. Patients with organic cerebral damage caused by head trauma, cerebrovascular disease or other diseases were excluded from the study, as were those with hypertensive or other changes on the retina.

METHODS

A brief description of the methods used:

Complex Reactiometer Drenovac (CRD), an electronic psychodiagnostic system, operates using numerous instruments. In this study we applied CRD 4-A test which provokes operative thinking, i.e. the function of central regulation of complex psychomotor reactions. The test consists of 35 tasks of different complexity. The subject is asked to react as quickly as possible to signal lamps, by arm and/or leg pressure.

CRD 4-A test variables:
TT - total time for completion of the test (general level of ability)
Err - total number of errors in the test (reliability of structure)
Tmax - the longest time at any of the tasks (inertia)
MS - maximum speed at any of the tasks, apart from the first one (dynamics)
% TB - the percentage of total ballast which is the sum of the differences between maximum speed and partial reaction times at the test.

Total ballast is an expression of inner stability of specific mental functions. The percentage eliminates extremity, making it suitable for interpretation.

Electroencephalography (EEG) was performed with a 12-channel apparatus under standard conditions. The following variables were used for statistical analysis:
Class - classification of the recording
Ampl - amplitude of basic rhythm (in microvolts)
Fr - frequency of basic rhythm (in hertz)
HV/FS - changes in hyperventilation and photostimulation
Block - blockage of basic rhythm by eye opening

RESULTS AND DISCUSSION

Results are presented descriptively, using χ^2-test. The question remains whether or not alcoholics had a regular or irregular EEG.

The following tables show relationships that indicate more pronounced grouping, with significant χ^2-test values.

Table 1 shows the frequency of different CRD 4-A variables for 88 alcoholics classified as normal, or the anticipated results. Depending on the variable 23–36 per cent of the results can be described as normal. The same table also shows the percentages of normal indicators of EEG variables. The percentages are much higher.

Table 1 *Frequency of normal results at CRD 4-A test and EEG variables (n=88)*

	Variables	Normal results	%
CRD	TT	32	36
	Err	27	31
	Tmax	30	34
	MS	20	23
	% TB	32	36
EEG	Class	45	51
	Ampl	41	47
	Fr	44	50
	HV/FS	70	80
	Block	41	47

The differences shown in the frequency of normal findings between the two methods indicate the probability that alcoholics have more pronounced deficits in complex psychomotor reaction times than in EEG variables. The following tables show the overlapping of deviations found by these two methods. Table 2 shows that 80 per cent of our sample with deviations in the frequency of the basic rhythm had a prolonged total time (TT) at the CRD 4-A test, whereas only 45 per cent of them had normal frequency.

Table 2 *Relationship between the frequency of the basic rhythm and total time at CRD test (in sec)*

EEG frequency	CRD TT			
	up to 100	101-300	301 and more	Total
8-12 Hz	2 (55%)	16 (36%)	4 (9%)	44 (100%)
Higher or lower	9 (20%)	29 (66%)	6 (14%)	44 (100%)
Total	33	45	10	88

$\chi^2 = 10.974$; $P < 0.005$

Table 3 shows the difference in the category "over 21 total errors at CRD", where 57 per cent of the subjects had a decreased or increased frequency of the basic rhythm and only 23 per cent had normal frequencies.

Table 3 *Relationship between the frequency of the basic rhythm and total errors at CRD test (CRD Err)*

EEG frequency	CRD Tmax			
	up to 10	11-20	21 and more	Total
8-12 Hz	13 (29%)	21 (48%)	10 (23%)	44 (100%)
Higher or lower	14 (32%)	5 (11%)	25 (57%)	44 (100%)
Total	27	26	35	88

$\chi^2 = 16.312$; $P < 0.001$

The relationship between the frequency of the basic rhythm and maximal inertia (Tmax) indicates the expected tendency for the highest frequency of the smallest inertia to be found in alcoholics with normal EEG frequencies (Table 4). Subjects with the normal frequency of the basic rhythm reached the maximum speed of up to one second at any CRD task (Table 5).

Table 4 *Relationship between the frequency of the basic rhythm and the maximal time for solving a task at CRD test (Tmax) (in sec)*

EEG frequency	CRD Tmax			
	up to 10	10.1-20	20.1 and more	Total
8-12 Hz	22 (50%)	10 (23%)	12 (27%)	44 (100%)
Higher or lower	9 (20%)	15 (34%)	20 (46%)	44 (100%)
Total	31	25	32	88

$\chi^2 = 8.452$; $P < 0.05$

Table 5 *Relationship between the frequency of the basic rhythm and the maximum speed for solving a task at CRD test (MS) (in sec)*

EEG frequency	CRD MS			
	up to 1	1.1-2	2.1 and more	Total
8-12 Hz	16 (36%)	22 (50%)	6 (14%)	44 (100%)
Higher or lower	5 (11%)	30 (68%)	9 (21%)	44 (100%)
Total	21	52	15	88

$\chi^2 = 7.593$; $P < 0.05$

Tables 6, 7 and 8 show the relationships between the variable "blockage of the basic rhythm" and three CRD variables (TT, Err and MS). Thus, good blockage follows the greatest percentage of relatively fast total reaction times at CRD, and a smaller percentage of increased total errors at the same test. Furthermore,

three times more alcoholics with a good blockage reach the maximum speed of up to one second than alcoholics with a partial blockage or none at all.

Table 6 *Relationship between the blocking of the basic rhythm and total time at CRD test (CRD TT) (in sec)*

Blocking	CRD TT			
	up to 100	101-300	301 and more	Total
Good	22 (54%)	14 (34%)	5 (12%)	41 (100%)
Partial or absent	11 (23%)	31 (66%)	5 (11%)	47 (100%)
Total	33	45	10	88

$\chi^2 = 9.725$; $P < 0.01$

Table 7 *Relationship between the blocking of the basic rhythm and the total number of errors at CRD test (CRD Err)*

Blocking	CRD Err			
	up to 10	11-20	21 and more	Total
Good	9 (22%)	21 (51%)	11 (27%)	41 (100%)
Partial or absent	18 (38%)	5 (11%)	24 (51%)	47 (100%)
Total	22	51	15	88

$\chi^2 = 0.001$; $P < 0.001$

Table 8 *Relationship between the blocking of the basic rhythm and the maximum speed at CRD test (MS) (in sec)*

Blocking	CRD MS			
	up to 1	1.1-20	2.1 and more	Total
Good	17 (41%)	18 (44%)	6 (15%)	41 (100%)
Partial or absent	5 (11%)	33 (70%)	9 (19%)	47 (100%)
Total	22	51	15	88

$\chi^2 = 11.200$; $P < 0.005$

The variable "frequency of basic rhythm" in EEG relates to total time and total number of errors at CRD 4-A tests. Thus a normal frequency from 8 to 12 Hz is followed by a higher percentage of "speed" reactions and greater accuracy. The same holds for the variable Tmax (maximal inertia).

In healthy subjects eye opening during the EEG recording causes alpha rhythm (8-12 Hz) to change to beta rhythm (13-30 Hz). According to our previous results the physiological alpha rhythm is reduced in alcoholics (12). This is very

probably the reason why in more than 50 per cent of the alcoholics in this study eye opening induced only a partial blockage of the basic rhythm or none at all. Tables 6 and 7 show the relationship between blockage on the one hand and speed and accuracy at CRD on the other.

The results of our study suggest that neuropsychological alterations in reaction time may be related to neurophysiological processes, i.e. the frequency of the basic rhythm may be related to the speed of the psychomotor reaction. These results corroborate those of *Pfefferbaum and co-workers* (13), who found prolonged reactions to visual and auditory evoked potentials in alcoholics. Consequently, we consider that both methods should find application in everyday clinical practice in the evaluation of the effects of long-term alcohol abuse.

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Sažetak

SLOŽENO VRIJEME REAKCIJE I ZNAČAJKE ELEKTROENCEFALOGRAMA U ALKOHOLIČARA

Na skupini od 88 muškaraca alkoholičara provedeno je testiranje pomoću psihodijagnostičke elektronske serije CRD (Kompleksni reakciometar Drenovac) i snimljen je elektroencefalografski nalaz (EEG). Dobiveni rezultati upućuju na povezanost frekvencije osnovnog ritma u EEG nalazu te bržih i točnijih reakcija na CRD 4-A testu. Također je nađena povezanost dobrog blokiranja osnovnog ritma otvaranjem očiju i bržih i točnijih reakcija na istom testu.

Ključne riječi:
cerebralne smetnje, duševna sposobnost, muškarci alkoholičari

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