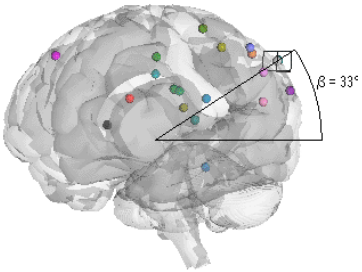
Illia Kuznetsov

Tetiana Kachynska

HUMAN PSYCHOPHYSIOLOGY LABORATORY SESSION



Lessia Ukrainka Eastern European National University

Biological Faculty

Human and Animal Physiology Department

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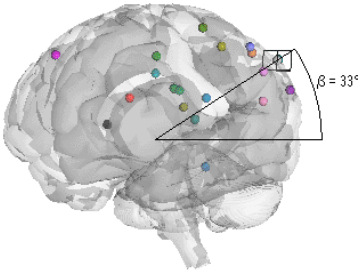
HUMAN PSYCHOPHYSIOLOGY LABORATORY COURSE

Laboratory session



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К89 Human psychophysiology. Laboratory session : [manual] / I. P. Kuznetsov, T. V. Kachynska. – Lutsk : Lessya Ukrainka Eastern European University, 2013. – 31 p.

Annotation: The manual may be used during "Human Psychophysiology" laboratory works for studying the basics of psychophysiological experiment design and interpretation. The manual is written taking into account the tasks of study course, which are specified by the program of higher education institutes. The manual has methodical recommendations for 11 laboratory works, with theoretical information, self-test questions and theme bibliography in each.

The manual intended for natural science specialties students of full-time and postal tuition of higher education institutes.

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TABLE OF CONTENTS

Laboratory work 1
Application of heart rate variability method in psychophysiological study

Aim and task: learn to apply the heart rate variability (HRV) method for physiological parameters study of human emotional responses.

Materials and equipment: An electrocardiograph with automatic calculation of HRV, Schulte tables, pointer.

Object of study: human subjects.

Theoretical information: Periodic components of HRV are grouped around several frequency ranges. One of the most clearly defined components is the so-called breathing or respiratory rate (RSA - respiratory sinus arrhythmia). Typically the respiratory rate is in the range from 0,15 to 0,4 Hz but children and adults during physical exercises may exceed the range. It's considered that the rate is conditioned by fluctuations (random changes) in vagus functioning, thus the respiratory rate characterizes the activity of vagus. Fluctuations in the values of R-R intervals are performed at low frequencies (LF) within 0,05-0,15 Hz and include a component with a frequency of 0,1 Hz (the so called 10-seconds wave or the Mayer wave). It's considered that HRV fluctuations at low frequencies are conditioned by sympathetic influences. Fluctuations of R-R intervals at lower frequencies refer to very low frequencies (VLF) - 0,003 - 0,05 Hz and ultralow frequencies (ULF), that is less than 0,003 Hz, which include circarian fluctuations. Very low frequencies are associated with thermoregulation cycles and renin-angiotensin system activity; the supersonic frequencies are associated with a number of circadian factors, including changes in activity, posture, breathing, autonomous processes, functional states and the rest of the behavioral factors. An important HRV characteristic is also the ratio of low to high frequency power (LF/HF ratio), that is the index of sympatho-parasympathetic balance. In general, the decrement of HRV indices (particularly, SDNN, the reduction of high frequency power) is associated with the influence of stress factors, while the increase of HRV indices is associated with positive emotional background, a condition characterized by good general state or relaxation of the body. Thus, by defining features of HRV we can estimate the degree of involvement of the subject into the performance of a specific task, including a cognitive one.

Progress of work. Electrodes are placed on the subject's head. The subject takes a sit on a chair in a convenient posture. After one minute ECG registration is started and lasts for 5 minutes. During the ECG registration the subject must be in a state of quiet wakefulness isolated of external stimuli. The second and the third ECG registration follow immediately the first one and last 5 minutes. During the second ECG recording the experimenter, using a pointer, indicates numbers on the Schultz tables and the subject must name the numbers pointed to if the graphical if the numbers are represented in color. The color is chosen by the experimenter before ECG recording and is made known for the subject.

During the third ECG recording the task is more complicated: the subject must name only odd numbers of depicted in a defined color. Thus complication of the task causes a raise of the subject's attention.

The study is repeated for the other 2 persons. Resulting from the ECG records the following HRV indices are registered: SDNN, RR50, high and low frequencies power, the ratio of low to high frequency power. The data is tabulated as following:

Subject's name	Record No.	SDNN	RR50	LF	HF	LF/HF
	1					
	2					
	3					
	1					
	2					
	3					
	1					
	2					
	3					

Make conclusions about the nature of autonomic responses to the increase of cognitive load.

Questions for self-study:

1. What is the variability of heart rate?
2. What factors influence changes in heart rate variability?
3. Explain why images of different emotional expression can influence heart rate variability changes?
4. On which of HRV frequency oscillations does the parasympathetic nervous system influence? Explain the mechanism of the influence.
5. What does the reduction of HRV indices indicate?

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Laboratory work 2
Methods of event-related desynchronization / synchronization (ERD / ERS)

Aim and task: Learn to use the method of **ERD / ERS** for the study of physiological indices of human mental functions.

Object of study: human subjects.

Materials and equipment: electroencephalograph, software for analyzing EEG curve power, a display for demonstrating the stimuli to the subject

Theoretical information: Hans Berger was the first to point out the basic EEG patterns conditioned by various stimuli, in particular - depression (a decrease in amplitude or its complete disappearance) of alpha rhythm in EEG wakeful person under the influence of external stimuli (e.g. while opening eyes) and its renewal after disappearance of these stimuli (e.g. while closing eyes). The research of Austrian scientists Pfurtscheller and Klimesh show that this reaction is valid not only for native EEG but it is also well-evident in the spectral characteristics of the EEG - alpha rhythm power decreases under the influence of a variety of stimuli or motions. Besides, these studies also revealed other important facts. Thus, according to the research of Pfurtscheller and Klimesh, different subjects demonstrated different EEG electric activity ranges responding to various stimuli, the ranges depended on the individual alpha rhythm (IR) frequency. Next, the different frequency components of the EEG spectrum, including those in the range of alpha rhythm, responded differently to stimuli of different types of cognitive load.

Thus, it is assumed that alpha-1 subrange is associated with conscious stimulus expectations, volitional attention, alpha-2 subrange is associated with mechanisms of maintaining the level of attention, alpha-3 subrange is associated with information semantic processing. Researchers proposed a method of event-related desynchronization/synchronization - ERD / ERS to define which EEG spectrum components react to certain types of stimuli. The main point of this method consists in comparision of EEG spectral power in certain ranges at a defined interval **before** stimulus input (reference interval, 3-4 seconds) and at a specified interval **after** stimulus input (from 1 to 4 seconds). The reaction ERD/ERS is often expressed in the form of EEG defined ranges power changes curve (Fig. 1) or in percentage term characterizing the relation of EEG before stimulus input to EEG power after stimulus input. In the second case the desynchronization corresponds to the index growth, the synchronization corresponds to the index reduction.

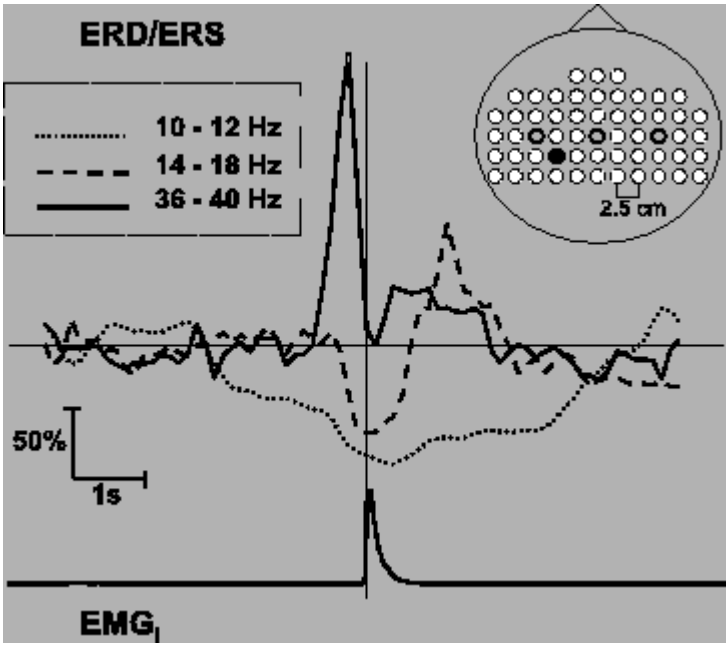

Fig. 1. Changes in EEG power in different ranges in response to motions

Progress of work. The system of electroencephalography is adjusted for conducting experiments. The subject sitting in a chair for an experiment, is placed the electrodes according to the system 10/20. EEG is registered in three experimental cases: 1) the functional state of rest with closed eyes, 2) response to significant stimuli (the subject is asked to press the button on the response panel when numbers are demonstrated on the screen and not to respond when the letters are displayed on the screen), a case when mechanisms of voluntary attention are activated; 3) response to significant stimuli with more complex response conditions (the subject is asked to press the button on the response panel when odd numbers are demonstrated on the screen and not to respond if the screen displays letters or even numbers), a case resulting in greater charging the mechanisms of voluntary attention when compared with the previous experimental test. After registering EEG alpha rhythm an individual frequency is determined as an indicator of the EEG signal center of gravity in the range 7-13 Hz at the first functional tests. If technically possible, it is recommended to determine the IF for each lead, and thus specify separate subranges for each lead. However, since this procedure requires a lot of calculation, an average IF for all leads is taken into consideration. In a laboratory study IF can be identified as a EEG center of gravity in the range of 7-13 Hz in one of the neck leads where EEG power in the alpha range is the highest. Then the limits of next ranges are defined independently upon the IF.

Range	Lower limit	Upper limit
Theta	IF-6	IF-4
Alpha-1	IF-4	IF -2
Alpha-2	IF-2	IF
Alpha-3	IF	IF+2

For example, if IR = 10 Hz, theta = 6.4 Hz, alpha-1 = 6.8 Hz, alpha 2 = 10.8 Hz, alpha-3 = 10-12 Hz, the EEG analysis program is adjusted for these ranges. Then for 10 significant stimuli in a randomly selected lead (parietal leads are recommended for choice: P3, P4 and Pz) the value of power on the reference interval is determined (3 seconds before the stimulus) and on the poststimulus interval (3 seconds after stimulus) for alpha-1, alpha-2 and alpha-3 subranges in the second and the third experimental tests (total - 120 values). The data is input into a table. ERD / ERS values for alpha-1, alpha-2 and alpha-3 subranges are calculated in the selected derivation are calculated for the second and the third experimental test (total - 6 values) according to Pfurtscheller –Aranibar equation:

$$ERD = 100\% * \frac{(SP_{(ref)} - SP_{(test)})}{(SP_{(ref)} + SP_{(test)})/2},$$

where SP_{ref} is a value of power in the reference interval, SP_{test} – is a value of power in poststimulus interval.
Make conclusions.

Questions for self-study:

1. What are the main characteristics of the electroencephalographic curve for a subject sitting with eyes closed at rest?
2. Explain the physiological nature of EEG rhythms synchronization/desynchronization process.
3. According to which values is the EEG synchronization/desynchronization analyzed?
4. What is the individual alpha rhythm frequency?
5. Calculate the limits of alpha and theta rhythms subranges if IF alpha rhythm equals to 10 Hz.

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Laboratory work 3
ICA-analysis of evoked brain activity

Aim and task: Learn to use the method of **independent component analysis procedure** to determine the localization of sources of evoked activity in the human brain.

Materials and equipment: electroencephalograph, software for ICA-analysis of evoked potentials and localization of sources of electrical activity, a display to demonstrate stimuli to the subject, a panel for recording the subject's responses, interactive electronic atlas of human brain anatomy.

Object of study: human subjects.

Theoretical information:

ICA-analysis (independent component analysis) is a mathematical procedure of compound signals analysis. The so-called "Cocktail party problem" demonstrates the concept of ICA-analysis to extract what one person is saying when others are speaking at the same time (Fig. 2). As we can see from the figure, for restoration of output signals several sources for recording the cumulative signal are necessary (usually these sources have different spatial location). Concerning EEG, the dipoles will serve as independent signal sources that are formed by groups of neurons. The quantity of restored sources equals to the quantity of recording channels, equals to one. The result of ICA-has a form of a matrix where in rows (the quantity of which is equal to the quantity of recording channels, equal to one) values of signals components are represented. Thereafter, the cumulative signal represents a linear sum of component signals. It should be noted that there are doubts about the appropriateness of using ICA-analysis of EEG data, so as the mixing of component signals is unlikely to be linear due to the heterogeneity of brain structures. However, this procedure is considered to be valid for determining the sources of evoked electrical activity.

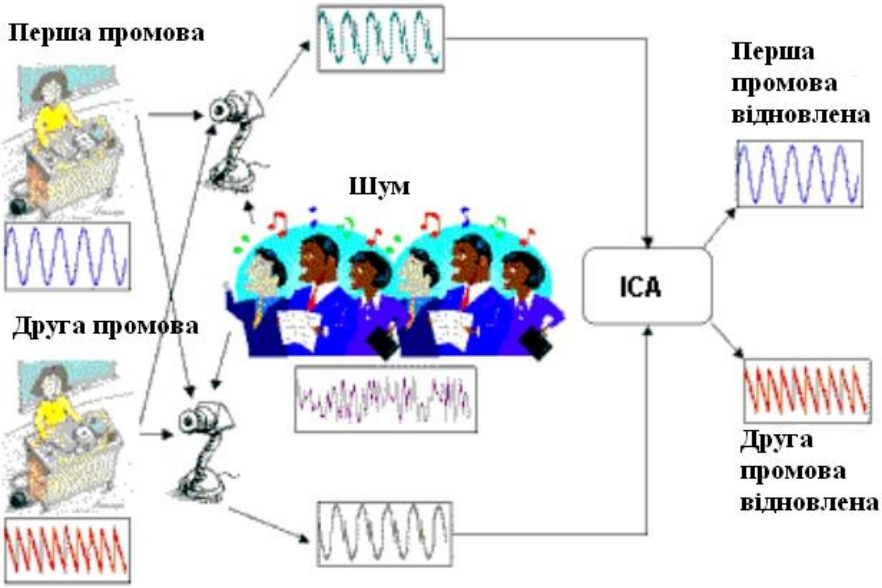

Fig 2. Principle of application of ICA-analysis

Progress of work. Existing ERP records are used for the ICA-analysis. The first stage of ICA-analysis is the output EEG analysis (press button "Overaccumulation of evoked potentials"). The second stage, the ICA-analysis procedure (context menu, select "Properties") results in receiving a matrix of component signals which is to be saved. Among the components of signals only those are chosen that are easily accumulated, taking into consideration possible artifacts. Thus, the visual stimulation may cause accumulation of oculographical artifacts. Using the localization option of the EEG complex (choose tab "tomograph"), coordinates are allocated and registered of selected ICA-components according to Talairach (Fig. 3).

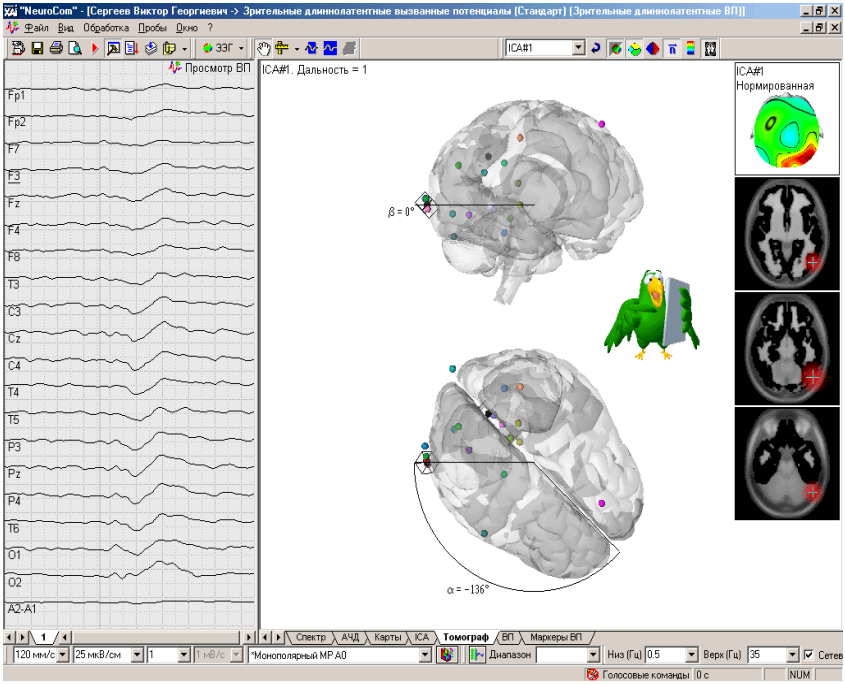

Fig 3. Result of analysis of ICA-components localization in the system of computer EEG

The procedure is repeated for some more records, in which the same protocol was used. The average value of the selected ICA-components coordinates is determined. Using the interactive atlas of the brain, the location of selected ICA-components for the averaged data is determined.
Make conclusions.

Questions for self-study:

1. What is the ICA-analysis of evoked activity of cerebral cortex?
2. What is a component of ICA-analysis?
3. What is the essence of ICA analysis of the cerebral cortex activity and how is it carried out?
4. What are the advantages and disadvantages of the ICA-analysis method?
5. Is it possible to determine the location of ICA-components without analyzing independent components?

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Laboratory work 4
Psychophysiology of Functional States

Aim and task: Learn to identify types of human functional state proceeding from the EEG characteristics.

Materials and equipment: electroencephalograph, EEG patterns samples in different functional states.

Object of study: human subjects.

Theoretical information: Two principal functional human states are distinguished: wake and rest sleep. Proceeding from EEG specific characteristics 5 different stages of sleep are distinguished.

The wake state with limited stimulation (e.g., with closed eyes, when the subject is relaxed, with some types of meditation) for the major part of the subjects is characterized by a clearly defined regular occipital alpha rhythm, modulated in the spindle.

With open eyes in the wake state irregular beta and gamma rhythms predominate during EEG registration. In the frontal parts under intense mental activity and emotional reactions theta rhythm with the amplitude not exceeding 50 mcV can be registered.

NREM sleep. Stage 1 (falling asleep, drowsiness, somnolence). The initial stage of sleep of an adult lasts 5-10 minutes. Muscles are getting less active, the eyes roll slowly. The basic rhythm gets replaced by theta waves with an amplitude equal or exceeding the alpha rhythm. Sharp vertex waves can be observed during EEG recording. Sudden twitches and hypnic jerks may also take place at this stage.

Stage 2 (shallow or light sleep). Further reduction of tonic muscle activity. Body temperature starts to decrease and heart rate begins to slow. Eyes are

moyionless. In EEG by theta waves dominate, the following typical EEG patterns of the second stage appear: the sleep spindles (similar to alpha spindles, but usually they are longer and have a higher frequency) and K-complexes (Fig. 1).

Fig. 4. K-complexes

It takes about 45-55% of total sleep time. The first episode of the second stage lasts about 20 minutes.

Stages 3-4 (the slow, delta sleep). The period of the deepest sleep. Low EMG activity, eyes are motionless. High-amplitude delta oscillations dominate in EEG. The stage is classified as the third stage if delta waves occupy less than 50% of the analyzed epoch and the fourth stage if the delta makes more than 50%. The third stage lasts 5-8% and the fourth stage is about 10-15% of common sleep time of a healthy person. The first episode of delta sleep can last 30-40 minutes. This is the stage in which night terrors, sleep talking, sleep walking and child's bedwetting occur.

REM sleep. This sleep stage is associated with vivid dreams (the latter can also take place in other sleep stages, but are much less expressive). It is characterized by rapid eye movements, irregular heart rate and breathing, increased blood pressure, general muscular atony (contraction of some muscles of face and limbs can be observed). EEG is asynchronously, alpha and beta range appear fluctuations, saw tooth waves are observed. Electroencephalogram reflects the state of activation and it resembles EEG of the first stage of sleep. The first episode of REM sleep occurs within 70-90 minutes after falling asleep and takes 5-10 minutes. The duration of subsequent REM episodes increases during the sleep, and at daybreak the duration is counted in tens of minutes. The REM phases of adults makes about 20-25% of the total sleep time.

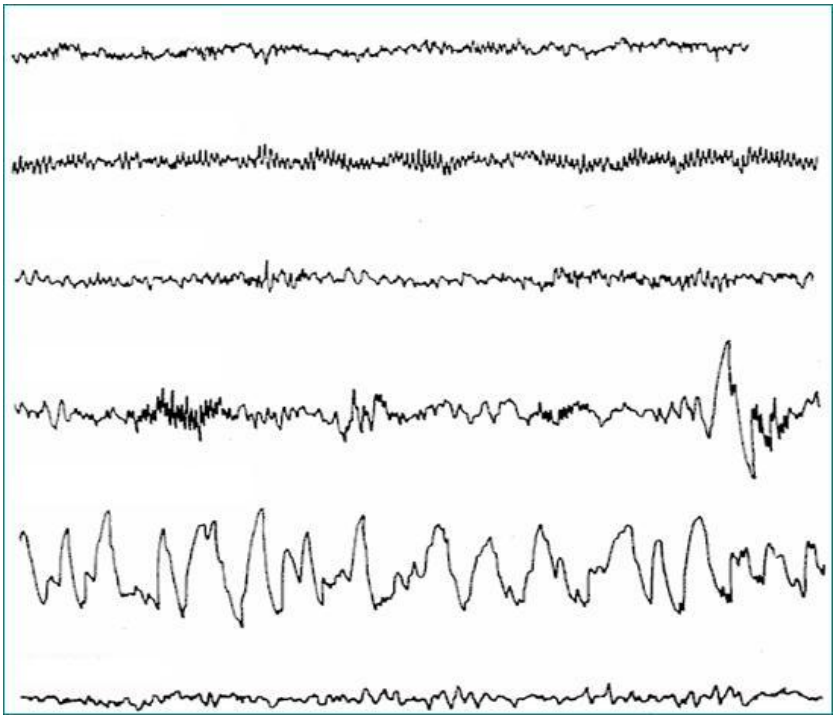

Fig. 5. Types of EEG in a wake state and in different stages of sleep

Work flow. Define types of functional states presented in Fig. 5. Specify the features of EEG range which are characteristic for different types of functional states. Using available EEG data draw conclusions about the functional state of the EEG subject.

Questions for self-study:

1. What is the functional state and what are its main characteristics?
2. What methods are used for studying functional states of the body?
3. Sleep and its physiological meaning.
4. What are the main characteristics of subject's EEG curve during the state of somnolence?
5. What is K-complex?
6. With what stage of sleep is associated the origin of K-complex?

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Laboratory work 5
Mental functions motivation support electrophysiological correlates

Aim and task: learn to use the method of potentials connected with events to study motivation support of mental functions.

Materials and equipment: electroencephalograph, software for ICA-analysis of evoked potentials and localization of sources of electrical activity. A display for demonstrating stimuli to the subject, a control panel for registering reactions of the subject.

Object of study: human subjects.

Theoretical information: One of the most distinctive indicators of the motivational function of man is contingent negative variation (CNV). The CNV represents an evoked potential that appears in the result of missing an expected stimulus that follows the warning stimulus. Therefore, the contingent negative variation is also called expectancy wave or E-wave. It is known that the amplitude of CNV depends on many factors, the most principal of which is the motivation of the subject to complete a task. As to the topographical characteristics of CNV, the power peak of the wave is observed in the frontal area. CNV appears around the 150th millisecond after missing the expected stimulus and usually lasts 200-300 ms.

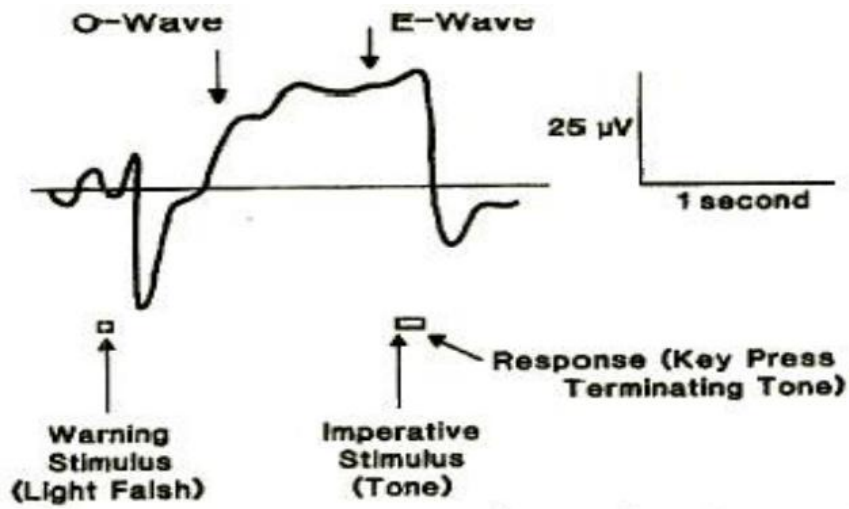

Fig. 6. Contingent negative variation (, E-wave)

Conduct CNV registration according to the conventional method. Analyze the characteristics of registered potential according to amplitude and time characteristics. Determine the basic ICA- CNV components.

Make conclusions.

Questions for self-study:

1. What is contingent negative variation?
2. What is the time span between the stimulus and e-waive emergence?
3. What higher integrative brain function is characterized by the appearance of E-wave?
4. What component of cortex evoked potential corresponds to contingent negative variation?
5. What factors influence the development of E-wave?

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Laboratory work 6
Evoked potentials method application for study of emotional reactions

Aim and task: learn to use the method of potentials connected with events to study emotional reactions of a human being.

Materials and equipment: electroencephalograph, software for ICA-analysis of evoked potentials and localization of sources of electrical activity, a display for demonstrating stimuli to the subject, a control panel for registering reactions of the subject, a set of stimuli: emotion faces.

Object of study: human subjects.

Theoretical information: The study of electrical activity of the human brain during emotional reaction is complicated by the following factors: bioethics issues that arise when applying emotionally significant stimuli, the necessity for accurate registration of emotional reactions (e.g., simultaneous recording of galvanic skin reaction and EEG), subjectivity of responses to emotiogenic stimuli (to which one subject responds emotionally positively and another one emotionally negatively).

Usually, these difficulties are avoided by using emotional reactions as stimuli. It is considered that with recognition of emotions the subject's response neural mechanisms correspond to the displayed emotion sample. However, this method is more delicate in relation to the subject's own impressions of the subject, and, moreover, is more accurate in terms of determining the aspect of emotions that the subject will feel (the same emotions that are transferred to the image, although less pronounced).

Work flow. Using three types of images with emotion faces (positive emotions, negative emotions, neutral expressions) to conduct two rounds of ERP registration. In the first series in the capacity of significant stimulus positive emotion faces were used and in the capacity of irrelevant stimuli neutral emotion faces were demonstrated. In the second series in the capacity of significant stimuli negative emotion faces were used and in the capacity of irrelevant stimuli neutral emotion faces were demonstrated.

Compare obtained evoked potentials as to the amplitude and time characteristics, waives expressiveness of evoked potentials in the right and left hemispheres. Conduct ICA analysis of obtained evoked potentials, determine the

anatomical localization of ICA components in the first and second series of tests. Compare the first and second series. Make conclusions.

Questions for self-study:

1. What are emotions?
2. Which hemisphere of the cerebral cortex is responsible for the perception of positive emotional stimuli?
3. What is the role of the reticular formation in shaping the emotional state?
4. Emotions are generated in the following structures:
   A) medulla;
   B) reticular formation;
   B) frontal areas of the cerebral cortex;
   D) hypothalamic structure;
   A) limbic system;
   D) cerebellum.
5. According to which theory the main role in emotion generating belongs to the reticular formation, located in the brain stem?
   A) Anokhin's biological theory;
   B) Simonov's Information theory;
   B) Lindsley's activation theory;
   D) James-Lange's somatic theory.

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Laboratory work 7
Studying working memory characteristics by applying P300 method

Aim and task: Learn to use the method of events related potentials for the study of working memory.

Materials and equipment: electroencephalograph, software for ICA analysis of evoked potentials and localization of sources of electrical activity, a display for demonstrating stimuli to the subject, a control panel for registering reactions of the subject, a set of psychological tests to determine the subject's working memory, psychological testing data and evoked potentials of other subjects.

Object of study: human subjects.

Theoretical information: to date the most popular model in psychophysiological studies of working memory is Alan Beddli's model according to which working memory is a system that provides temporary storage for information, manipulates this information to solve complex cognitive tasks. The working memory volume is limited (corresponds to the volume of working memory, that is 7 ± 2 items), material that is not used at the moment to solve the task or gets stored in the long-term storage or gets lost. The author identified three main components of working memory: the core is the central processor that coordinates the work of two subsystem buffers: the phonologic chain (works with verbal information) and visual-spatial matrix (responsible for processing of visual information). In its turn, the work of the central processor is tightly connected with the functions of attention, first of all, voluntary attention. Accordingly, the contemporary analysis of the late ERP components is a description of the interaction of memory and attention functions, and all reactions to common stimuli are considered from the standpoint of attention resource allocation and memory for solving the problem. Complex of components N200-P300 (Fig. 7) is the most sensitive evoked potentials components to the characteristics of memory obtained using the technique P300. It primarily N200 amplitude characteristics are very closely related to the function of memory. It is known that the pathology of the simultaneous presence of N200 P300 peak instability characterizes violation of RAM and process focused attention, and increase the latency of P300 in the absence or partial preservation of N200 suggests reducing the amount of RAM.

Complex of components N200-P300 (Fig. 7), obtained by P300 technique, is the most sensitive to the characteristics of working memory. At the same time primarily amplitude characteristics N200 are considered to be very closely related to the function of working memory. It is known that in case of pathology the availability of N200 accompanied by P300 peak instability evidences of working memory impairment and the process of purposeful attention. Absence or partial preservation of N200 indicates the reduction of working memory capacity.

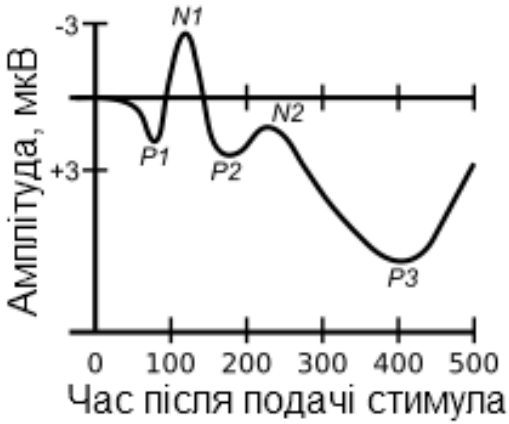

Fig. 7. Wave P3 (P300)

Work flow.

Conduct the experiment in two stages. At the first stage register P300 in response to the names of animals, using names of plants as an insignificant stimulus. At the second stage use the names of birds as significant stimuli and the names of plants and other animals as insignificant stimuli (complication of the instructions that corresponds to an increase of working memory load). Identify and compare the amplitude-time characteristics of EP at the first and second stages. Determine the subject's working memory capacity with the help of psychological tests. Compare the subject's results with the results of other subjects. Make conclusions.

Questions for self-study:

1. What is working memory?
2. What physiological processes are characterized by wave P300?
3. What are the temporal and topographical characteristics of wave P300?
4. What is the neuroanatomy of "What" and "where" system?
5. The system "what":

A) analyzes different features of the stimulus in the area of inferotemporal cortex;

B) defines the location of the object in the field of vision by neurons of the parietal cortex.

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Laboratory work 8
Studying long-term memory characteristics by applying P300 method

Aim and task: for the study of long-term human memory learn to use the technique of potentials related to events.

Materials and equipment: electroencephalograph, software for ICA analysis of evoked potentials and localization of sources of electrical activity, a display for demonstrating stimuli to the subject, a control panel for registering reactions of the subject.

Object of study: human subjects.

Theoretical information: The method of evoked potentials makes it possible to study electrophysiological indicators of both working and long-term memory processes realization. Typically, the method of studying long-term memory with the help of evoked potentials presupposes that the subject is given a task to memorize some words, images, sounds, and after a span of time (min. in a day) the subject undergoes registration of evoked potentials, in this case memorized words (sounds, images) are used as significant stimuli and other words (sounds, images) that were not to be memorized are used as insignificant stimuli.

It should be noted that in this case the subject is not always confident of reacting to meaningful stimuli: in some cases, the subject is sure of recognizing

the stimulus, in other cases the stimulus falsely seems to belong to the list of stimuli to be memorized. According to modern research, in the first case P300 component is recorded with a power peak in the parietal areas and with shorter latency, in the second case the power peak is shifting towards the frontal areas and latency P300 component is characterized by a longer duration. Correspondingly, in studies of this kind it is highly important to register the subject's correct/false responses as well as to determine the time between the start of the demonstration of the stimulus and the subject's response to this stimulus. Registration of these characteristics leads to more objective conclusions about the subjective perception of stimuli by subjects.

Work flow. Apply words denoting birds used in the previous laboratory work to study the electrophysiological responses during long-term memory functions performance. Correspondingly, the subject is to be the same as in the previous laboratory work. Names of birds not used in the previous laboratory work will serve as insignificant stimuli. The subject is set a task to press the right button of the panel if being sure that the stimulus was used in the previous laboratory work, and the subject is to press the left button of the panel if not being confident of using the stimulus in the previous laboratory work. Identify the typical evoked potentials for different types of reactions. Identify ICA-components and topography of obtained evoked potentaials. Identify and compare the amplitude-time characteristics of evoked potentials for different types of reactions. Make conclusions.

Questions for self-study:

1. What is memory? Types of memory.
2. What is the mechanism of long-term memory?
3. What structures of the cerebral cortex are responsible for the operation and storage of information in the long-term memory?
4. What is the topography of P300 component during response to a significant stimulus (memorized words, sounds, pictures)?
5. Duration of storage of information in long-term memory:
   A) few seconds;
   B) few years;
   B) life-long;
   D) from several minutes to several years.

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Laboratory work 9
Reflection of voluntary attention mechanisms in ERP late positive components

Aim and task: with the aim to study human voluntary attention learn how to use the method events-related potentials.

Materials and equipment: electroencephalograph, software for ICA analysis of evoked potentials and localization of sources of electrical activity, a display for demonstrating stimuli to the subject, a control panel for registering reactions of the subject, psychological tests for measuring attentional capacity.

Object of study: human subjects.

Theoretical information: The main components of ERP reflecting the mechanisms of voluntary attention are considered to be components P300 (P3a, P3b). These ERP components occur approximately at the 300^{th} ms (when using odd-ball paradigm during registration of evoked potentials). It should be noted that P3b (sometimes simply denoted as P3 or P300) is a response to a rare significant stimulus, whereas P3a is a response to a rare new (unexpected) stimulus. It is assumed that in the first case (during P3b registration) voluntary attention mechanisms are involved for keeping significant stimulus in the field of consciousness, whereas P3a registration secures envolvement of search engines in the environment and expectation of significant new stimulus. Location on the topographic maps above the central area of the cerebral cortex is a characteristic feature of the P3 component power peak, whereas during P3b component registration its peak power is observed over the parietal cortex area (Fig. 8). It is assumed that the P3 component amplitude is directly dependent on the level of mechanisms of voluntary attention involvement.

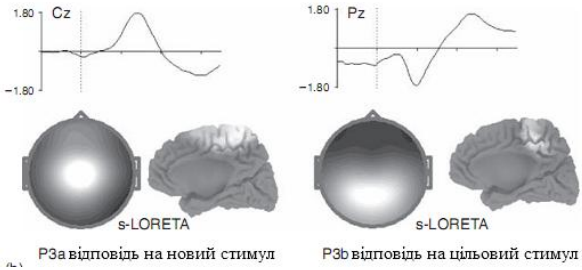

Fig. 8. P3a and P3b components and their amplitude-time xharacteristics and topography

Work flow. Conduct post R3a and P3b components in two different persons. Determine the amount of attention in subjects with psychological tests. Compare the amplitude of the P300 component of the results of psychological tests. Make conclusions.

Questions for self-study:

1. What is attention? Types of attention.
2. The basis of voluntary attention is:
   A) a controlled and supraliminal process, aiming at the selection and processing of necessary information;
   B) orienting reflex caused by any sudden change of situation.
3. Which brain structures are responsible for the formation of voluntary attention?
4. Which cortex evoked potentials components are responsible for the processes of attention?
5. The most important attention regulator in the capacity of selective process and state of consciousness in the whole is:
   A) hypothalamus;
   B) reticular formation;
   B) frontal cortex;
   D) hippocampus.

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Laboratory work 10
Attention study applying Stroop effect

Aim and task: for the study of automatic information processing to learn applying the method of potentials related to basic for voluntary attention events.

Materials and equipment: electroencephalograph, software for ICA analysis of evoked potentials and localization of sources of electrical activity, a display for demonstrating stimuli to the subject, a control panel for registering reactions of the subject.

Object of study: human subjects.

Theoretical information: Application of images suitable for reflecting the Stroop effect in the capacity of stimuli during evoked potentials and EEG registration is one of the most popular study methods of preconscious information processing and attention processes organization mechanisms. Stroop effect is a demonstration of interference when naming the color of the word if the name of a color is printed in a color not denoted by the name.

Obviously, the cause for the interference is a preconscious processing of semantic information which results in involuntary attention involving before processing of the demonstrated stimulus. Changes in ERP waves parameters, to begin with latency and N180, P300 amplitude, in psychophysiological researches are considered to be the result of mental activity of this kind.

Work flow. Perform ERP registration in accordance with the odd-ball paradigm. Implement ERP registration in two stages. At the first stage the subject is demonstrated stimuli in the form of names of colors printed in colors denoted by the names. The subject is to react to the green color of the letters.

During evoked potentials registration at the second stage the subject is demonstrated stimuli in the form of names of colors printed in green but denoting another color. The subject is to react to the green color of the letters.

Compare main components of the received evoked potentials of the first and the second stages to latency and amplitude values and then define the basic ICA-components, which are formed at the first and second series. Make conclusions.

Questions for self-study:

1. What is the effect of Stroop, what is its physiological nature?

2. In which components of cortex evoked potentials the Stroop effect is evident in study of attention?
3. What is the procedure of cortex evoked potentials registration according to oddball paradigm?
4. Which physiological processes can be studied and analyzed using the oddball paradigm?

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Laboratory work 11
Psychophysiological indices of simple motor act central organization in the ERP Go/NoGo paradigm

Aim and task: for the study of human higher motor functions to learn applying the method of events related potentials.

Materials and equipment: electroencephalograph, software for ICA analysis of evoked potentials and localization of sources of electrical activity, a display for demonstrating stimuli to the subject, a control panel for registering reactions of the subject.

Object of study: human subjects.

Theoretical information: the essence of this paradigm is that the subject is given a task to by movement (e.g. pressing the button) react to a specified significant stimulus which is demonstrated on the background of insignificant and more frequent stimuli which not to be responded to. Meanwhile, ready signal is demonstrated (prestimulus) before each significant or insignificant stimulus. Thus, after the prestimulus demonstration the subject is in a state of readiness for movement. But in case of insignificant stimulus demonstration the subject has to slow down an already prepared motion.

Quite often this method is provided by feedback information about correctness or incorrectness of the subject's actions (pressing the button). The

method makes it possible to distinguish clearly components with duration of 200-300 ms when compared to ERP methods according to the oddball paradigm.

Work flow. Perform research according to the ERP method in accordance to the Go/NoGo paradigm. Determine the amplitude and latency of N180 and P300 components. Conduct ICA analysis of evoked potentials. Compare the received evoked potentials with those obtained according to the oddball paradigm. Draw conclusions about the paradigms characteristics and organizing simple motor act.

Questions for self-study:

1. What is the essence of cortex evoked potentials registration according to the Go/NoGo paradigm?
2. What are the advantages of the Go/NoGo paradigm if compared to the oddball paradigm?
3. What process in the cerebral cortex can be studied and analyzed using the Go/NoGo paradigm?
4. Components of which latency can be recorded and collected best by the paradigm of Go/NoGo?

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FOR NOTES

Study-methodical edition

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