ABSTRACT
of the dissertation for the degree of Doctor of Philosophy (PhD)
in the specialty "6D050300-Psychology"
Borbassova Gulnur Nursaynovna
on the topic: "Psychophysiological study of the influence of emotional states and individual differences on executive control"

The aim of our study was to investigate the effect of individual differences and emotional state on executive control based on the relationship with electrical brain activity.

To achieve the goals of the study, the following objectives were defined:

1. Methodological:

- critical analysis of scientific literature and determination of the theoretical and practical significance of the study of influence of emotional state and individual differences on control of cognitive functions.

- validation and adaptation of scientifically-based methodological complex of psychometric, behavioral and encephalographic (EEG) research.

2. Empirical:

- to establish the relationship between emotional states and individual differences;

- to determine the influence of emotional state and individual differences on behavioral parameters of attention networks during cognitive task performance;

- to determine the influence of emotional state and individual differences on EEG parameters of attention networks during cognitive task performance and their prognostic relevance;

- to determine the relationship between behavioral indicators during cognitive task performance and corresponding dynamic electrophysiological changes in brain activity;

- to investigate gender differences in emotional state and executive control.

The general hypothesis of the study: emotional state and individual differences influence the function of neural networks of executive control.

The general hypothesis was elaborated into the next specific hypotheses:

- Psychometric parameters of emotional state correlate with individual characteristics;

- Behavioral parameters of neural networks of executive control depend on emotional state and individual differences;

- Parameters of electrical brain activity (event-related potential) in dynamics during task performance depend on emotional state and individual differences;

- Behavioral indicators of task performance correspond to the dynamics of changes in brain activity during the task;

- There are gender differences in emotional states and attention networks.

The theoretical and methodological bases of the research were:

The present scientific research study was based on the integration of theoretical and methodological foundations of Personality Psychology, Cognitive Psychology and Neuroscience, such as the Five-Factors model of individual differences (Big Five, John

& Srivastava, 1999), Eysenck's theory of extroversion and introversion (K.Y. Eysenk, 1947), the concepts of emotional states (R. Lazarus 1968, O. Gross, 1998) and mood (G. Matthews et al., 2002; Watson, Clark, Tellegen, 1988), the theory of anxiety (Hanin & Spielberger, 1983), the concepts of a three-level structural-functional model of regulation of higher mental functions (A.R. Luria, 1973), the theory of the functional system (P.K. Anokhin, 1971); models of cognitive control by A. Miyake, N. Friedman (A. Friedman, N. Miyake, 2017), M. Posner's concept of neural networks of executive control, vigilance and orientation (M. Posner, 2012), and others.

The choice of methodology of the experiment is based on the concept of M. Posner and on the basis of numerous studies using the internationally recognized behavioral task on the neural network of attention (Attention Network Test, Fan et al., 2002), activating three neural networks: alerting, orientation and executive self-control. Functional magnetic resonance imaging (fMRI) studies by M. Posner's research group allowed to define anatomical structures responsible for the functioning of three neural networks: 1) executive control – prefrontal cortex, anterior cingulate gyrus; 2) alerting - right frontal cortex, superior parietal lobe; 3) orientation - frontal eye field, tempoparietal junction, pulvinar, superior colliculus (Peterson & Posner, 2012). The informativity and validity of the ANT task was confirmed by electroencephalographic (EEG) studies using induced potential methods for stimuli, respectively activating three systems of attention: 1) for executive control – congruent and non-congruent flankers; 2) for vigilance – double cue and no cue; 3) for orientation - spatial and central cue stimuli (A.H. Neuhaus et al., 2010). The behavioral study of executive control, conducted by Zholdassova M.K., Kustubayeva A.M., Matthews J. (2012), was the basis for this experiment with the expansion of the methodological approach to electroencephalography. Previous studies confirmed validity of the ANT task in the local population. The task was adjusted to event-related design of EEG experiment. All psychometric methods were translated into the Kazakh language and validated on the local population.

Research methods were chosen based on the subject, hypothesis and objectives of the study:

- *theoretical*: systematic review of research literature related to the problem of the influence of emotional state and individual differences on cognitive control;

- *empirical methods*:

1) Psychometric methods

- The Big Five Questionnaire (NEO-FFI personality questionnaire John & Srivastava, 1999);

- The Positive and Negative Affect Schedule (1988), developed by D. Votsan, L. Clark and A. Telegen;

- The Spielberger-Khanin Anxiety level Test (STAI, State-Trait Anxiety Inventory, Hanin & Spielberger, 1983);

- Dundee Stress Questionnaire (measuring mood), (DSSQ, The Dundee Stress State Questionnaire, Matthews et al., 2002).

2) Behavioral methods

Modified version of the ANT task programmed in E-Prime (Fan et al., 2002, Zholdasova et al., 2013). The performance of the ANT task allowed to measure behavioral indicators (reaction time) to target stimuli of the following categories:

a) for executive control network– congruent and incongruent flank stimuli;

b) for the orientation network – central and spatial cue stimuli;

c) for the alerting network – cue and no cue stimuli.

Primary analyses were done in E-Prime. Further analysis of the networks was done by subtracting the reaction time of the corresponding indicators.

3) EEG study.

EEG recording was done with "Neurosoft" (Ivanovo, Russia) with international 10-20% system of the electrode placement in the following situations: 1) open eyes (1 min); 2) closed eyes (1 min); 3) ANT task performance (event design). ERP parameters were calculated for each category of stimuli using EEGlab/ERPlab software based on Matlab.

4) Statistical methods.

Statistical analysis was performed using the statistical package IBM SPSS 23.0 with One-way ANOVA, correlation analysis with Pearson criteria, repeated measures ANOVA.

5) Study participants.

One hundred and two volunteers were examined (49 males and 53 females) from 18 to 45 years old. The study was approved by the local ethics committee at the Al-Farabi Kazakh National University (№1125-2; №1600). All participants, after reading the information list with research aims and objectives, signed the written consent.

The theoretical significance of the research was that it allowed to systematize the theoretical prerequisites for this study, to expand and deepen modern ideas on the scientific problem of executive control; to determine the relationship between theories of emotional states, individual differences and control of cognitive functions. The obtained research results on the interaction of emotional states and individual characteristics with cognitive control contribute to the understanding of individual differences in cognitive control.

The practical significance of the study was in the development of an integrative psychophysiological methodological complex of study design for defining the model of the influence of emotional states and individual differences on executive control, and its validation in the Kazakh population.

The obtained results revealed the most significant parameters of the dynamic emotional state (state), and the features of individual differences (trait) that affect executive control. The model can be implemented in higher educational institutions of Kazakhstan when planning educational activities and developing individual approaches in the organization of educational processes to optimize cognitive control. The study of individual differences in cognitive control is important for providing recommendations to improve the reliability of cognitive functions in professions requiring high cognitive workload. The results can be applied in the optimization of working hours and in the hiring process of specialists and operators.

Novelty of the study

- for the first time, an integrative methodological complex of psychophysiological experimental study on the influence of emotional state and individual differences on executive control in the Kazakh language was inculcated and validated;

- for the first time, the relationship between emotional state and individual characteristics was revealed on the basis of psychometric and behavioral data;

- for the first time, the influence of emotional state and individual differences on behavioral indicators of ANT task performance (alerting, orientation and executive control), and their correspondence to dynamics of brain activity were determined;

- scientific novelty at the international level was in determining the relationship of emotional state, individual differences with parameters of brain activity (event-related potentials) in the dynamics of the task;

- for the first time, gender differences in emotional states were revealed, which are reflected in indicators of executive control.

Provisions for PhD thesis defense:

- Systematic review of current background literature on individual differences, emotional states, executive control allowed to distinguish several areas of concepts that justified the necessity and validity of our study.

- An integrative methodological complex of psychophysiological experimental study of the influence of emotional state and individual differences on executive control in the Kazakh language showed validity in the Kazakh population;

- Emotional states and individual characteristics based on parametric data are correlated with each other;

- Emotional states and individual differences affect behavioral indicators of performance on the ANT task;

- Emotional states and individual differences affect the parameters of brain activity (event-related potentials) in the dynamics of task performance;

- Gender differences in emotional states are reflected in measures of executive control.

Description of the PhD student's contribution to the preparation of each publication.

The main results of the research were presented to the attention of the scientific community in presentations of the author at international and regional scientific conferences, where they received a positive assessment. Eleven articles have been published on the research topic, including in journals recommended by the Committee for Control in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan - 5; in international scientific and practical conference proceedings - 5; in a journal included in the international Scopus database - 1:

Psychophysiological theories of the mechanics of emotions // Bulletin of kaznu. Psychology and sociology series. Almaty, No. 4 (63), 201 P. 6-12; on adaptation of the Kazakh-language version of the five-factor personality questionnaire "Big Five" / / Bulletin of KazNU. Psychology and sociology series. Almaty, № 4 (67), 2018, P. 125-133; Psychophysiological research diagnostics of emotional and depressive states // Bulletin of KazNU. A series of psychology and sociology. 2018, № 2(65), P. 102-108;

Individual features in executive control // Bulletin of KazNU. Psychology and sociology series. Almaty, № 3 (40), 2019, P.74-84; Study of the depressive state of university students using the Kazakh-language version of the" depressive state assessment questionnaire" (IDs) // Bulletin of KazNU, pedagogy series. 2020, No. 3 (64), P. 38-47; Theoretical review of the PANAS questionnaire// international scientific and methodological conference "psychology in the modern world: theoretical and Applied Research in the context of the implementation of the "Ruhani zhangyru" program", dedicated to the 30th anniversary of the opening of the Department of psychology of Al-Farabi kaznu. Materials of the International Conference. Almaty "Kazakh University" 2018, P. 41-42; Electroencephalographic study of emotions // international scientific and practical conference" Psychological Science and practice in modern society: problems, practice, future". Almaty, 2018. P. 294-297; Executive Control and Brain Activity in People With High and Low Levels of Depressive Symptoms // Biological Psychiatry. 2019, №85(10S). – P.S159-S160. **ImpactFactor: 11.501**; «Temporal changes in ERP amplitudes during sustained performance of the Attention Network Test» International Journal of Psychophysiology. 2022.182, P. 142–158 DOI 10.1016/j.ijpsycho. 2022.10.006; Problems of psychophysiological study of individual differences // collection of the international scientific and methodological conference on fundamental and applied scientific research: actual problems, achievements and discoveries. Almaty, 2023, P. 399-402.

Compliance with the directions of scientific development or government programs. The dissertation corresponds to priority directions of science development mentioned in the "The State Program for the Development of Education and Science of the Republic of Kazakhstan for 2020-2025", approved by the Government of the Republic of Kazakhstan dated from December 27, 2019; the strategic developmental plan of the Republic of Kazakhstan until 2025 on "New Human Capital", approved by the Decree of the President of the Republic of Kazakhstan dated from February 15, 2018; and the program "Rukhani zhangyru".