Human professional activity during spaceflight (SF) on board orbital stations takes place under the conditions of permanent microgravity, which demands special skills both in everyday practice and in controlling the modern hardware and equipment; in the long view, there will be still more difficult conditions of interplanetary missions with international crews. The SF conditions may induce the development of various forms of mental maladaptation; e.g., it is necessary to enhance the reliability of medical and psychological control of the state of health of crew members and to elaborate adequate measures for support and correction of their psychoemotional state and performance efficiency in the unusual habitat [11].

Among the mechanisms of human adaptation to the set of SF factors, in addition to microgravity-induced responses of physiological systems and the shifts in homeostasis parameters, the effect of the central nervous system (CNS) via subcortical brain structures on the state and humoral regulation of metabolism is of great importance; e.g., it is necessary to enhance the reliability of medical and psychological control of the state of health of crew members and to elaborate adequate measures for support and correction of their psychoemotional state and performance efficiency in the unusual habitat [11].

Vestibular studies revealed the psychophysiological and biochemical correlates of susceptibility to motion sickness [9], one of unfavorable manifestations of space adaptation syndrome [2]. Integrated investigations of long-term antiorthostatic hypokinesia (ANOH) simulating SF conditions showed interrelationship of the hormonal state and psychomotor reactions, the comfort, reliability and functional-speed peculiarities of activity with the dynamics of concentration of adrenocortical hormones in blood, the central effects of neuropeptides and hormones of the hypothalamic—pituitary system, the concentrations of catecholamines, sex and thyroid hormones in blood, and the ratio of serotonin- to dopaminergic activity of cerebral structures [8, 10, 20]. The studies during a 135-day isolation revealed the relationship of psychoemotional state and performance efficiency to the level of free cortisol in saliva [4, 5]. Moreover, ANOH and isolation under the conditions of gravity simulate mainly the monotony of environment, postural and motional limitations, hemodynamic and hypokinetic effects; the effects of other SF factors on human organism, i.e., support deprivation and reduced proprioceptive afferentation, must be studied in experiments with suite or dry immersion (DI).

DI investigations identified the significant cross-correlations between separate parameters of operator’s activity and the association of thyroxin with choice reaction [1] but left open the question about peculiarities of responses of the tested volunteers to the presented impacts depending on their personality traits and temperament. Such investigations provide not only the estimation of actual psychic condition, but also identification of prognostic criteria for speci-
fication of the strategy of adaptive reactions that would ensure the maintenance of working efficiency under extreme environmental conditions, because the success of human activity in the unusual habitat, in the opinion of many authors, is associated with individual psychological features of personality related to the categories of temperament [3, 6, 7, 14–19].

Therefore, the main goal of this work was to study the peculiarities of psychophysiological and hormonal states of operators during SF with due consideration for extra/introversion and anxiety as the most important properties of temperament.

METHODS

The studies with seven-day immersion were approved by the Commission for Biomedical Ethics. Eight male volunteers, 19–32 years old, got the permission of the flight certification board and gave their informed written consent to participation in the experiment. The volunteers continuously stayed in an immersion bath except for 15–30 min per day spent for hygienic procedures. The daily caloric content of foods and water consumption of the volunteers were normalized as per kilogram of body weight; food consumption was balanced with respect to the main nutrients, K⁺, and Na⁺, and depended on the body weight.

The psychophysiological state investigations and venous blood sampling were carried out in the morning hours, on an empty stomach, in the pre-experimental (background) period before the immersion (day –7), on days 3 and 7 of exposure, and in the recovery period (seven days after DI completion). Prior to the experiment, all volunteers were trained to work with computerized psychophysiological techniques. During the experiment, the tests were performed in the immersion bath.

Neuroendocrine control parameters were determined in blood plasma and serum samples taken from the ulnar vein (venipuncture). The blood was centrifuged; the serum and plasma samples were dispensed into aliquots, frozen, and stored at –40°C until the concentrations of insulin, prolactin, follicle-stimulating hormone (FSH), cortisol, thyrotrophic hormone (TTH), thyroxin (T₄), and triiodothyronine (T₃) were determined by the methods of enzyme immunoassay using commercial test kits from DSL, Monobind (United States), and Spectria (Finland).

The intensity of absorption spectrum in the samples was measured in a Biorad analyzer (United States); hormone concentrations were calculated using the MultiCalc software (Wallac, Finland) by means of an IBM PC AT.

The set of methods for psychophysiological state estimation included the study of individual psychophysiological characteristics, operator’s qualities, and peculiarities of visuomotor coordination using the Sensor and Tsentrovka software [1–3, 8] for assessing the capacity of short-term memory (STM), the latent period of simple motor response (LPSMR), the latent period of visomotor response (LPVMR), and central delay (CD) during presentation of light signals, choice reaction time (CRT), and absolute error (AE) in pixels during performance of the task on comparing the sizes of two visual images were measured. The above programs provided automated recording of examination results, calculation of variance and coefficients of variation of each parameter followed by saving into the measurement protocol file. The total time of work with the software was 20–25 min.

In the pre-experimental period, the volunteers once answered 187 questions of Cattell’s Personality Factor (16-PF) Questionnaire [14, 15].

The determined parameters were used to generate an array of the primary data; the data were processed by means of Statistica for Windows v. 5.1 (StatSoft, Inc.) and SPSS 10.0 (SPSS Inc.). The primary results and the generated array of variables were analyzed by the following methods of statistical analysis [12]:

—Preliminary analysis (exploratory data analysis, basic statistics calculation, identification of the type of distribution curve, analysis of outliers, etc.).

—The study of differences between samplings, the search of relationships between several variables (correlation and regression analysis with the Pearson’s parametric and Spearman’s nonparametric coefficients).

—Derivation of multiple regression equations by the method of successive addition of variables.

The significance of differences between the samples was estimated by parametric Student’s t test or the nonparametric Kolmogorov–Smirnov test.

RESULTS AND DISCUSSION

Analysis of the mean values and standard deviations of the tested parameters suggests that the results altogether correspond to the generally accepted reference values; multivariate analysis of the type of distribution of basic quantitative parameters of the sampling showed their close conformity to the normal law of error (the Gaussian law).

Subjects were divided into groups with different individual psychological features of personality and properties of temperament according to the 16–PF second-order factor scores: “high/low anxiety” (F2) and “extraversion/introversion” (“exviantnost–inviantnost” in the original, F1) [3, 15]. It should be noted that the subjects were grouped according to the properties of temperament without any polar estimates; in fact, a higher or lower intensity of anxiety and extra/introversion was taken into consideration, because the F1 and F2 factor scores on a 10-point scale were usually in the range of 3–6 stens (from standard ten).

The first step of estimation of personality traits of the subjects was calculation of F2 values. As a result,