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Experimental confirmations of bioeffective effect of magnetic storms

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EXPERIMENTAL CONFIRMATIONS OF BIOEFFECTIVE EFFECT OF MAGNETIC STORMS

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The results of experiments for the determination of the influence of geomagnetic field disturbances on a human organism are considered. We used the method of electropuncture diagnostics by R. Voll for this end. The method is based on measurements, of conductivity in acupuncture points and is convenient because it allows us to estimate deviations from the norm in the functioning of various organs in the same units. The local A-index is used as an indicator of geomagnetic field disturbance. The daily measurements of the group (27 persons) have shown the presence of a synchronous mass response of inspected people on magnetic storms. At first it is exhibited as a sharp (within 3–4 hours) increase of conductivity of all the acupuncture points from normal values, which corresponds to a maximum of adaptational capabilities of an organism; and then a long duration (about 4 day) decrease of conductivity that describes the depression of all organs and systems of an organism. The reaction of adaptation on three magnetic storms of identical intensity going with an interval per week was registered for half of the inspected people. It was found that the duration of the depression phase and the imbalance of an organism, intrinsic to this phase, depends extremely on the wholeness of the organism (that is on the power of ties between organs and coordination of their activity), but not on the type of disease.

KEY WORDS Magnetic storms, human organism, stress-factors, adaptation capabilities, electroacupuncture

1 INTRODUCTION

People are part of a biosphere, just like any live organism. Therefore it is quite natural that a person connected to the external environment, and dependent on it, his adequately adapted to its changes during his existence on Earth. For example, the response of our organism to changes of air temperature as a regulation of body temperature and to illumination by the expansion and narrowing of a pupil is not subject to doubt. But the external environment is not only atmosphere and visible radiation, but also electromagnetic, gravitational, acoustic and seismic fields, all part of a spectrum of solar and space radiation that is inaccessible to our sense

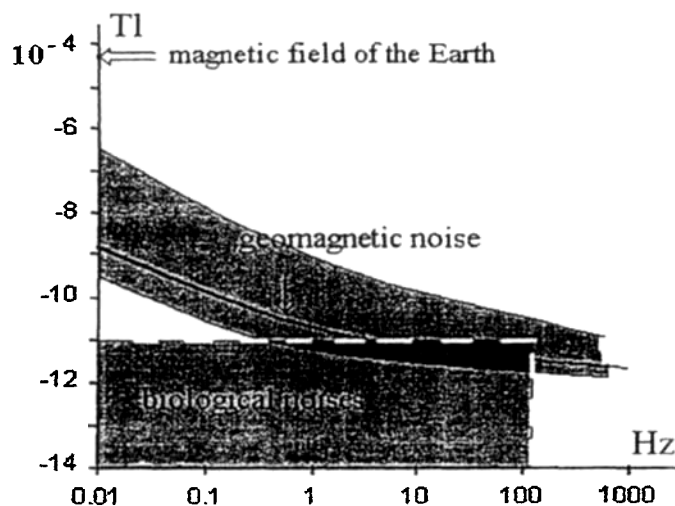


Figure 1 This picture illustrates the interception of frequency bands of a magnetic storm and the own EMF of various organs radiation of a person. It is necessary to expect the active response of an organism in the field of interception of these ranges. The frequency and strength of the magnetic field are shown on the axes of abscissas and ordinates accordingly.

organs. But our inability to feel some effect does not mean the absence of this effect. For example, there is the widely known protective response of human skin to ultra-violet radiation, which is invisible to the eye – sunburn. Hence less obvious responses of an organism to, for example, changes of electromagnetic field (EMF) may exist also. Recent experiments speak of the truth of this statement. They have shown that the various organs of a person are sources of a weak magnetic field up to 10^{-7} – 10^{-9} Tl (*Physical Encyclopedia*, 1990). The strength of this field is less than the strength of the constant magnetic field of the Earth and technogenic noise on a several orders. Why do we consider this problem in detail if such strong effects do not render visible influences on our organism? But a man is a difficult non-linear system and ‘more’ does not mean ‘more effective’ for him (Breus, 1998). However, people meet weak fields much more often than strong and it does not hinder the normal functions of a man. Hence, the problem is not only in intensity. Apart from amplitude, the frequency of EMF oscillations plays an important role. Our organs actively radiate in the frequency band from 0.01 up to 100 Hz (*Physical Encyclopedia*, 1990). Accepting the hypothesis that the mechanism of the response of an organism on external weak fields is mainly based on resonance, it would be logical to assume, that EMF with similar frequencies of oscillations can render a bioeffective effect. The basic possibility of the existence of similar responses is underlined, for example, in the work of Riznichenko and Plusnina (1996), Kamenir and Kirillov (1998). Figure 1 shows that the range of biological noise is intersected with the range of magnetic field variations of the Earth. So the supposition about the effect of magnetic storms on a man has an actual basis in itself, because the magnetic

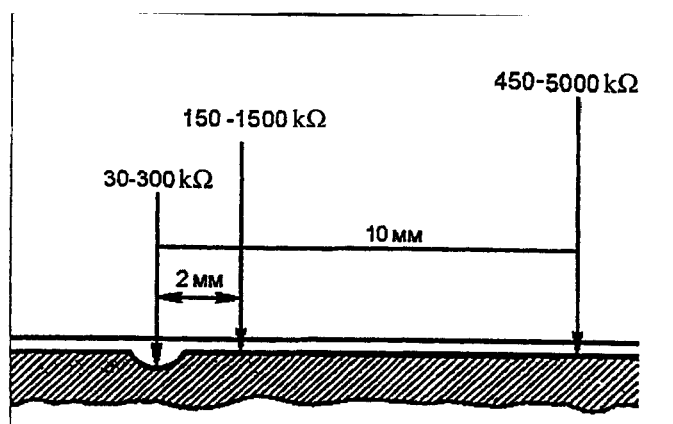


Figure 2 Change of electrical resistance of the skin depending on the distance up to the acupunctural points.

storm is not only a jump of the components of the geomagnetic field, but also has specific irregular geomagnetic variations with a period of 1–150 second (Saito, 1974). Moreover, the rhythms of biological systems are described by 'wanderings' of phase and amplitude; they are similar to rhythms of gelio-geomagnetic parameters that facilitate their 'tuning' under the rhythm of the external synchronizer (Breus *et al.*, 1995).

2 TECHNIQUE OF THE EXPERIMENT

If we consider a person as an object of research, then a problem arises: which technique must we choose for the registration of changes in an organism under the effect of external factors on this organism. If, for example, explorers take an interest in people's reaction to magnetic storms, the following types of investigations are carried out more often:

- The analysis of statistical data for a long duration period of time (processing of illness histories, number of calls 'of first aid' etc.). The technique, unfortunately, has strong social noise and its data are not always authentic.
- Biophysical experiments at a cell-like level and analyses of blood (outside of an organism). In this case it is necessary to take into account the difference between properties of cells and blood *in vitro* and their properties in a live organism.
- Medical functional diagnostics (measurement of pulse, temperature and pressure, ECG, magnetograms, ultrasound, gastroscopy). These rather full and authentic methods have shortcomings, too: the boundedness of the enveloped

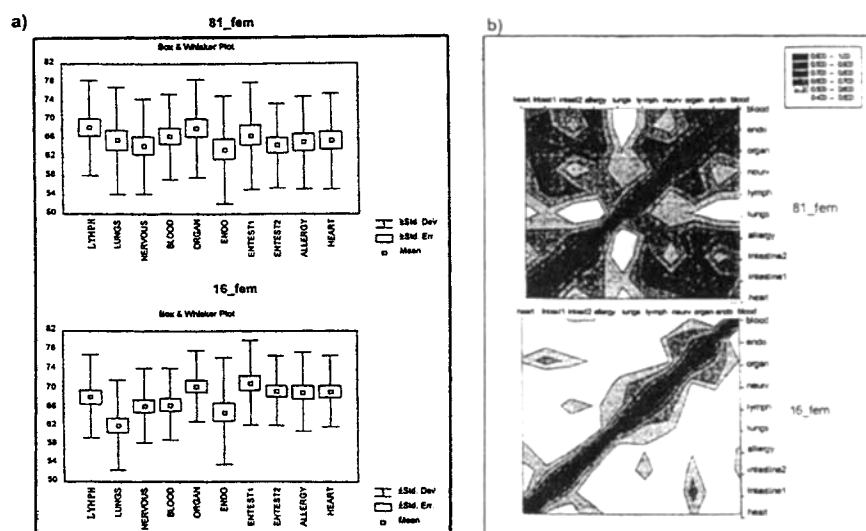


Figure 3 The diagram of standard deviations from the mean (a) and the matrix of mutual correlations (b) can be used as an individual portrait of the person. For 18_fem the high correlation of systems of an organism with each other is visible; the mean values of $F_{i,j}$ for different i have a small dispersion. It is characteristic of healthy people and people with a settled mechanism of a course of chronic diseases. 16_fem demonstrates a strong dispersion of mean and weak correlation between systems. It is the case characteristic of people of senile age or having acute inflammations.

systems, the impossibility of comparison of obtained results among themselves (we cannot compare frequency of pulse with acidity of the stomach); frequently these methods are shocking for inspected people.

We have used the method of electroacupuncture diagnostics due to R. Voll (Ionescu-Tigroviste and Bayenaru, 1984). This method is non shocking, objective in the description of both the whole organism and its separate systems. It is founded on the fact that a change of acupuncture point properties depends on the condition of the organism (Portnov, 1987). Acupuncture points are local sites of skin with diameter and depth of the order of 2–3 mm, which have increased temperature, electrical conductivity and other special properties (Figure 2). Thus, their characteristics vary synchronously with changes of the internal condition of an organism. The electropuncture diagnostic method uses changes of resistance in an electrical circuit passing through these skin sites as a diagnosing parameter. Similar research allows us to reveal rejection in the functioning of various systems of an organism most precisely. Moreover, Voll's method register a change of resistance with respect to normal, as a rule, earlier than first clinical indications of disease appear and sometimes earlier than they can register a deviation in the functioning of an organ by standard methods of medical diagnostics (Portnov, 1987).

Technically examination is carried out as follows the person appears live in a circuit of a continuous current. An inspected man holds the passive electrode in

one hand, the active electrode densely nestles to the chosen acupuncture point by pressing. Thus the point is irritated with a current of no more several μA . The healthy condition of an organ is characterized by its activation being equal to the force of an external irritation ($I \approx 8 \mu\text{A}$, $R \approx 100 \text{ k}\Omega$), thus the pointer of the device is established on 50 conditional units. The zero value of a dial corresponds to disconnected contacts; 100 units to short-circuit. The indication of the device in an interval of 50–70 units is considered as the norm in medical practice, from 50–40 as reduced function of an organ, and lower then 35 as destructive changes in an organ or system. If indications are higher than 70 units then there is hyperfunction, and values higher then 80–85 characterize an acute inflammation.

Thus, the offered technique allows us to express changes in functioning of various organs in the *same units* and this is the cardinal difference between this methods and all those described above. Monitoring measurement with the use of this technique have been made for the first time. For example, doctors actively using Voll's method inspect patients no more often than once per month, while we simultaneously inspect 27 persons of different age, sexes and with various conditions of health. The measurements are carried out daily by a MicroVoll device, certificated by the Russian Ministry of Health. The examination of volunteers is made with an interval at 3–4 hours in days of storms. Ten checkpoints describing the condition of the nervous, endocrinology, lymphatic systems; blood, lungs, thick and thin intestine, heart and organ degeneration, and allergy were chosen on both hands. The results of measurements for four months (during which 10 magnetic storms were registered) will be considered below.

3 INTERNAL TIES OF AN ORGANISM – CHARACTERISTIC OF OUR HEALTH

If we want to know the precise response to a particular storm, we must decide on a double return problem: to find out how the storms differ from each other and to define different people react to these storms. The technique of long duration measurements, used by us, allows us to decide the second part of this problem. Treating the obtained in formation, we aimed to find regularities presenting the influence of magnetic storms on the people and describing changes in an organism in the most simple and effective way.

Let us to designate by $F_{i,j}$ ($1 < i < 10$, $j = 1; 2$) the indication of the MicroVoll device in the measurement of the i -th acupunctural point on the left hand ($j = 1$) or right hand ($j = 2$). The diagrams of standard deviations of time series $F_{i,1}(t)$ and $F_{i,2}(t)$ were made for each examined person and all i matrices of conjugate correlations of these series were also calculated. We shall consider a coefficient of correlation between series $F_{l,j}(t)$ and $F_{k,j}(t)$ as an element of the matrix $m_{l,k}$.

The diagrams of deviations (a) and matrix (b) of two inspected people having code labels 16_fem and 81_fem, designed for case $j = 2$ on time frame April–May 1998 are shown in Figure 3. A number of points are given at once deciphered for

convenience (for example $j = 1$ means *lymph* \equiv lymphatic system); the values of the elements of a matrix are shown by the intensity of the colouring.

The diagrams of deviations give a representation of which organ is subjected to the greatest danger at unfavourable external effects. A large dispersion with respect to the mean (large values of the standard deviation) speaks about the instability of the organ condition, and a large difference between the mean values tells us about the instability of the organism as a whole.

The matrix of conjugate correlations (M_{bc}) describes the synchronism of various organs, response to external stimuli and is an individual physiological portrait of an examined person. A strong tie between the organs (the mean value of non-diagonal elements of the matrix $R_{\text{mean}} \sim 0.7$) is characteristic of both rather healthy organisms and for people suffering from chronic diseases. A weak tie ($R_{\text{mean}} < 0.5$) speaks about a non-simultaneous response of organs to the stress-factors, the reasons of which can be, for example, advanced age, acute inflammations and other cases of imbalance of systems of the organism. The case of a strong tie is demonstrated by the matrix of the examined 81_fem, and the case of weak tie by 16_fem (Figure 3).

A matrix of conjugate correlations and a diagram of deviations of each person characterize the common condition of an organism and have a smooth seasonal and diurnal course. Thus parameters can differ strikingly on different days.

4 COMPARISON OF DATA ROWS WITH LOCAL A-INDEX

The correlation coefficient R_A between the local A-index of the geomagnetic field and the time series $F_{i,j}$ for each person for all periods of measurements was calculated. It was found that as a rule R_A is not higher than 0.55 which corresponds to already known results (Lapko and Polikarpov, 1994; Thcijevsky, 1930; Smirnova and Plenkina, 1998). However, as a matter of fact, the research here is about the correlation with an undisturbed field, and it is impossible to judge the response of the person's organism to a storm using these values, as storms are a rarity and the period of quiet geomagnetic situation lasts much longer. Besides, the results of our experiments have shown the shift of the response peak is different in different seasons. For example, imagine that inspected N had a reaction to magnetic storm on the day of a storm in April, in May–June the day before, in July–August on two days after the beginning of the storm. Such changes inevitably should result in a drop of the correlation coefficient obtained on the whole file.

Sometimes the maximum of the cross-correlation function appears shifted with respect to a row of data A-index forward or back. It corresponds to an outstrip or delay of an organism's response concerning geomagnetic field variations, and if the delay can be explained, the resistivity of an organism just to geomagnetic field variations, the outstrip, obviously characterizes the response to any other kind of effect.

In spite of the fact that the binder of a time series of parameters $F_{i,j}$ with undisturbed geomagnetic field is not traced for the majority of inspected people

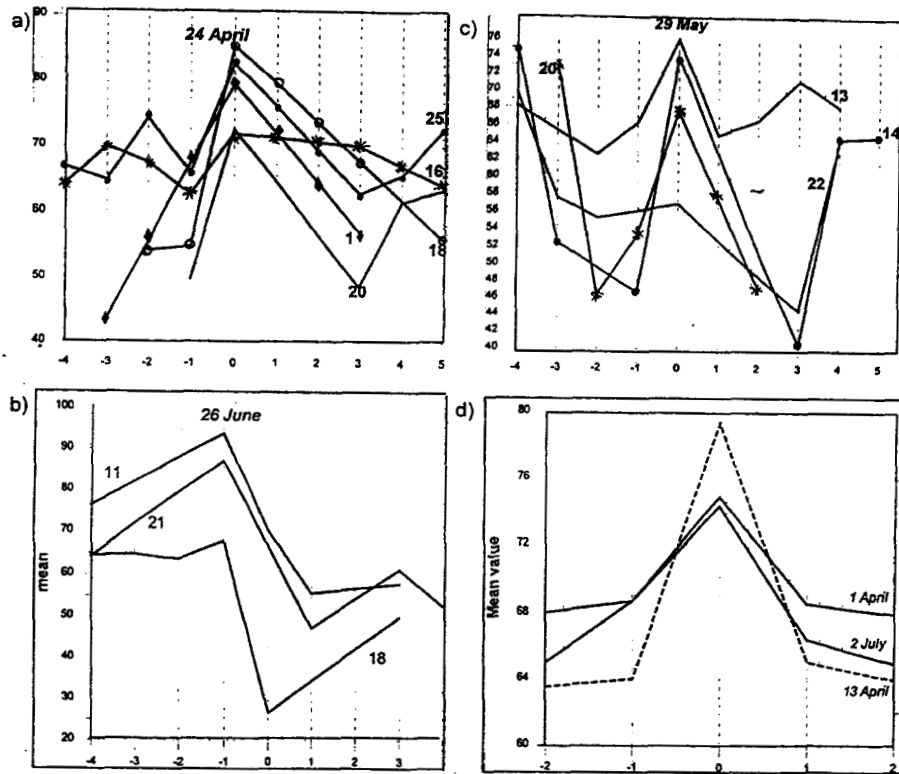


Figure 4 Response of different inspected people on magnetic storm (a) and (b); on the sharp increase of the K_p -index (c); a response of the inspected person on a sharp (within 1 hour) jump of pressure $\Delta P \geq 1$ mbar (d). (a) The phase of hyperfunction (a jump of mean values of $F_{i,j}$ calculated for all i above 65 units) with a consequent falling of values (phase of depression) within 3–4 days is well traced. (b) The phase of hyperfunction is not registered, but a phase of depression is clearly visible. (c) 50% of inspected people have reacted to the sharp jump of the geomagnetic field as in a storm. (d) Response to jumps of atmospheric pressure is characterized by the absence of the phase of depression.

(R_A is small), there are separate inspected people having a rather high correlation coefficient ($R_A \approx 0.8$). There are few of them – only 10% – and all of them have a strongly connected correlation matrix of organs with each other. It is possible to assume that the geomagnetic field is a constant external synchronizer for them.

So, the coefficient of correlation with changes of A-index calculated on the full file for a long duration period is not an effective enough index of the response of an organism to magnetic storms. Much more informative are the graphics plotted by the method of imposed epoch by Tchijevsky (Tchijevsky, 1976). These graphics describe the condition of an organism in the time frame ± 4 days in relation to the day of the beginning of a storm. *Similar mass* (up to 80% from of the common number of inspected people) *response* to magnetic storms is *clealy visible* on them.

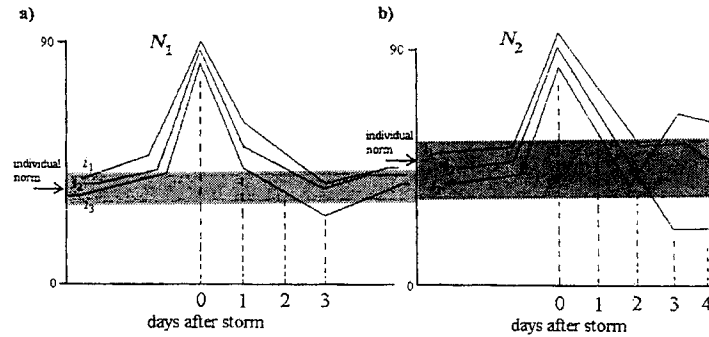


Figure 5 Difference in the phase of depression. The group N_1 (a) is characterized by a rather short phase of depression (2–3 days), the curve for various parameters rapidly aims at the area of the individual norm. A longer duration phase of depression and curve imbalance in this phase is characteristic for group N_2 (b).

It is expressed by a sharp change of all values $F_{i,j}$ on the day of the magnetic storm (Figure 4a).

In more detail: at the beginning a jump of $F_{i,j}$ to overstated values (> 60 units) is observed, this condition of hyperfunction lasts 3–4 hours and corresponds to the maximum of adaptation capabilities of an organism; then the depression (a sharp falling of values, sometimes even up to 20 units) is registered over two–three days. Therefore, even if we have not registered a jump of $F_{i,j}$ for those people which are inspected at the time per day, the phase of the depressed condition of an organism is visible (Figure 4a). So the expressed response, is not observed for 20% of inspected people, or the parameters $F_{i,j}$ sharply vary before or after the day the magnetic storm begins (± 3 days).

It is necessary to especially allocate a case when the mass response was observed one day prior to the storm on June 26 (Figure 4b). Also the case of May 29 (Figure 4c) attracts attention, when there was no storm, but a sharp jump of magnetic field within several hours was registered, thus the A-index value 20. The response of the type described above was given by 50% of the inspected people in this day. For the remaining the presence of a reaction was disputable.

Thus, the effect looks like a type of a stress-response and is accompanied by an increase of conductivity in the circuit passing through acupunctural points. The results of other investigators analysing the responses of blood circulation and nervous system in people and animals confirm this (Chibisov *et al.*, 1995; Breus *et al.*, 1998). It is necessary to note that the response to other stress factors essentially differs from the response to a magnetic storm in both the amplitude of the peak and the absence of a long duration depression phase (Figure 4d shows, for example, the response to sharp jumps of atmospheric pressure).

It is interesting that the curve of the mean on all points $F_{(i),(j)}(t)$ for different inspected people demonstrates a similar conduct 1–2 days prior to a magnetic storm, in spite of the fact that the clear, likeness between them was not observed up to it. It

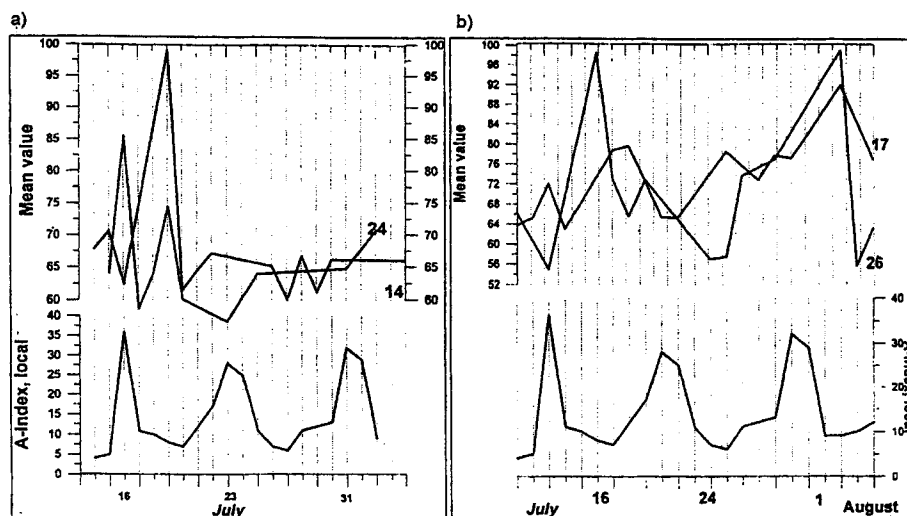


Figure 6 Response of inspected people on three successive storms of identical intensity. (a) Reaction of adaptation: the heavy splash of mean values of $F_{i,j}$ associated with the first storm and the absence of a response on remaining ones is observed. The values $F_{i,j}$ return in the area of the individual norm after a jump. (b) Absence of adaptation: the stress-reaction to all storms is observed. The curve of the mean of $F_{i,j}$ does not return to normal values even in the case of a smoothed response.

is, possible to assume that, though the majority of people do not have an expressed tie between the behaviour of parameters and the undisturbed field, the change of a geomagnetic field becomes the external synchronizer and for two days before a storm; or it happens due to any information signal of another kind preceding the approach of a magnetic storm.

It is necessary to note that complaints of bad state of health do not always coincide with the hyperfunction phase. They are more often characteristic of the phase of depression. Thus people with a poorly connected matrix M_{bc} have a longer duration depression phase in a comparison with the group of people, the M_{bc} , of which is strongly connected. The difference between the depression phase of these one is visible in Figure 5a and 5b. The curve of values $F_{i,j}$ for different i rapidly came to the mean, in this phase, for the group of inspected N_1 , while for group N_2 the strong imbalance in the curves behaviour for various i was observed. Thus, our experiments are not confirmed widespread judgment, as if the response of people to magnetic storm depends on a type of disease (see, for example, Lapko and polikarpov, 1994). The response depends on the synchronism of organ activity, and internal coordination, instead of the particular diagnosis.

One more interesting effect was noted: about 50% of inspected people have shown an adaptation-type response to three storms of approximately identical intensity going with an interval every 6–7 days: a heavy response to the first storm was observed and there was no response to subsequent storms (Figure 6a). The

values $F_{i,j}$ rapidly came to the normal after a jump. The other half of the inspected people had a standard or increasing reaction to the storms (Figure 6b). For this group of people the values of acupunctural point conductivity were increased with each subsequent storm, not returning in the area of the individual norm in the period between the storms.

Therefore, it is meaningful to make a test for the adaptation for those people that work with a frequent spectrum of fields close to the spectrum of magnetic storms (for example, for astronauts, personnel of submarines and drivers of electrictrains). Besides it is obvious that the technique offered us of monitoring measurements of acupunctural point conductivity allows us to estimate peoples' adaptational capability under the action of other stress-factors.

5 CONCLUSIONS AND DISCUSSION

Surveying the obtained results it is possible to tell that monitoring measurements with the help of the electroacupuncture diagnostics method confirm the fact of the effect of magnetic storms on people and enable us to look deeply in to the essence of these changes happening in an organism. The experimental technique and data processing allows us to estimate the changes of various organs in the same units operatively, which is very convenient for the description of an organism's response to external effects. Thus it was possible to reveal that:

- The response of an organism to a magnetic storm is identical in an overwhelming majority of people, despite differences in age, diseases and subjective sensations.
- The effect of magnetic storms is to cause a stress-response in organism, that is excitation of all systems of an organism is primary, but braking is not.
- The response to magnetic storms is divided into two phases: hyperfunction with a maximum of adaptational capabilities of an organism (several hours) and depression (several days). This response is characteristic *only* of magnetic storm; for the remaining stress-factors (such as change of atmospheric pressure weather conditions, family disorders) the phase of depression is sharply reduced (no more than a day).
- The intensity of the response to geomagnetic disturbance depends not on the type of disease, but on the coordination of the systems of organism activity. People with poorly connected matrixes of internal correlations endure magnetic storms most heavily, as their organism is strongly imbalanced during the phase of depression.
- The effect of adaptation to frequently recurring magnetic storms of identical intensity for 50% of inspected people is observed.

The fact that the curve of $F_{i,j}(t)$ describing the condition of an organism for various persons has a similar course for 2–3 days prior to the storm beginning indicates a response to forerunners of the magnetic storm. If to take into account that for some people the jump of values $F_{i,j}(t)$ happens for two days up to the magnetic storm, it is necessary to assume that people react to a change of the ionospheric or atmospheric parameters and parameters of the interplanetary environment that precede the development of a magnetic storm. The concrete mechanism of similar effects is not yet quite so obvious. However it is clear that if the type of reaction to geomagnetic disturbance depends on the person, the time of appearance of this response, then its presence is determined both by the structure of the magnetic storm and the previous history of its development. The further expansion of methods of measurement of peoples' organism health and methods of the fine structure of geomagnetic field oscillations and other parameter analysis during disturbances of a geomagnetic field are necessary. Also, it is necessary to carry out an in-depth study of events accompanying the origin and development of magnetic storms at a possible earlier stage.

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